INDIAN FORESTER.

JANUARY, 1934.

HIS EXCELLENCY THE VICEROY'S MESSAGE.

The *Indian Forester*, which was started as a quarterly after the Forest Conferences of 1873-74 and has been appearing as a monthly journal since 1883, celebrates its 60th anniversary this year. During its existence it has been a useful medium for the discussion of the many problems which concern forest officers throughout India and Burma and a convenient vehicle for the dissemination of information regarding developments in the science and practice of forestry both in this country and abroad. Its pages bear testimony to the range and the value of the work done and to the scientific and practical achievements of the Indian Forest Services whose initiative brought it into being and to whose sustained interest and effort on its behalf it owes its continuance. I wish the journal a career of progressive usefulness and success in the future.

WILLINGDON.

THE VICEROY'S HOUSE,
NEW DELHI,
24th November 1933.

PROLOGUE TO OUR SIXTIETH VOLUME.

The *Indian Forester* started its career sixty years ago as the outcome of a resolution of the Forest Conference held at Allahabad in January 1874. The moving spirits in this venture were Messrs. B. H. Baden-Powell, J. L. Laird, J. S. Gamble and A. Smythies,

under the guidance of Dr. D. Brandis, who was then Inspector General of Forests, and with Dr. W. Schlich as their first editor. The larger share of the credit must be given to Baden-Powell who was himself a prolific writer and whose initiative had produced the Punjab Forest Conference of 1870 which was the forerunner of the larger conferences of 1874 and 1875. A large proportion of the notes and articles in the early numbers are from his pen, and he was obviously interested in many other sides o forestry besides the legal one, with which his name has been perpetuated in his books on "Forest Law" and "Land Revenue." The subject of starting a forest magazine was doubtless discussed at the earlier conferences though it is not specifically mentioned in their proceedings, for it was on the answers to a previously issued questionnaire that the resolution of the Allahabad meeting was based. It was not until 1875, however, that the first number appeared as a quarterly.

That the aims and policy of the magazine have been maintained throughout its life is well brought out by a reference to Dr. Schlich's "Prologue" from which we quote below, for its statement of the case and its emphasis upon the need for all forest officers helping according to their talents holds just as firmly to-day as it did for the first number.

"Our object is to supply a medium for the intercommunication of ideas and the record of observations and experiments, as well as to catch all stray fragments of information, all *facts* and *data*, and supply the places of 'Notes and Queries' to the Forest Service generally."

"As to our principles, they are decidedly liberal and independent. We, and all who communicate with us, are free to express what we think; we shall not repress any criticism on what we honestly believe to be wrong, or say anything that we do not believe to be true, to please *any one*. We shall endeavour to extenuate nothing, and we shall "set down nought in malice." But free, full and unfettered discussion of every principle and practice is the very life of forest science and forest art."

"That discussion it will be our endeavour to facilitate with all the means at our disposal. But this thing we will do—we will impress

on ourselves and our contributors the absolute maintenance of courtesy and good temper in the thick of the hottest discussion, and we will banish from our pages every thing that verges on personality or harshness of expression. Our criticism will be directed to measures, not men, to the opinions and utterances of the impersonal office, not to the thoughts and deeds of individuals."

"In pursuance of the general principles enumerated we do not propose to open our columns to personal grievances; but questions affecting the organization of the service, or a section of the service, are legitimately within our scope. We propose to allow ourselves the option of declining papers which are unsuited for publication, or which are based on absolutely unscientific grounds; but we trust that the exercise of this discretion will rarely need to be called into action."

"We have now earnestly to address our supporters in behalf of this new scheme of an Indian forest periodical. Above all we want steady contributors. Now many forest officers feel, and naturally so, that they have no time for writing. Others feel that they have no facility with the pen, and perhaps too modestly imagine that they can do nothing to help. With regard to this feeling, we would offer a few remarks. In the first place, while every number ought to contain a fair proportion of leisurely-written and detailed matter, that share of the work must necessarily be handed over to those who have a gift for writing, and who have the necessary literary machinery in the shape of books of reference to assist them. But the only value of a periodical of this sort will not consist in its containing elaborate essays. A large portion of it should be devoted to 'Scraps' and to brief 'Notes and Queries.' Every forest officer who is worthy the name keeps a note-book, and as some new fact or some new experience comes to his notice, or some 'happy thought,' tending to the facilitation of some portion of his work, flashes across his mind, he will make a rough note of it. There is actually no one who can go about from day to day on plantation work, up and down a river on timber transport business, demarcating a forest, making valuation surveys, or engage in any other

branch of his ordinary business, but must see something, and learn something, which is in itself valuable, and a distinct addition to the stock of facts which are the basis of all rational and practical progress in forest administration."

"And here is the line for the forest officer who loves not desk and blotting-paper. Send us in, then, rough and unartificial, from your note-book jottings. A diamond, even uncut, is a diamond still; and even if we cannot always have a diamond, we can have a crystal, and that is a very good thing in its way. We beg every one to send what he has, and not to subject it to a preliminary criticism, and put it on one side. 'I did not think you would care about it; I thought it hardly worth sending,' are sentences that consign to inutility many really valuable facts, many good suggestions, that may contain the germs, perhaps as yet only partially developed, of future progress, or of some important economy."

"Another way of helping may be indicated to those whose taste or the sterner call of duty forbids literary work—'ask *questions.*' The interchange of opinions and expressions on all sorts of forest matters will be most useful, and it will create a good discussion, which will be of vital importance to our paper."

"We shall endeavour ourselves to keep a good look out for information gleaned from home literature, as well as that of other countries, but we would invite every one to call our attention to articles or other sources of information of this kind, and to correspond with friends at home, with a view to keeping us informed of the progress of forest literature, furnishing us with notices of recently published books, stating the price and class. Communications regarding the supply of forest material to public works, improvements to be made in transport, information regarding seasoning timber and impregnation, regarding buildings, hill roads, cheap bridges, and numerous other connected subjects, will doubtless enable the latter class to benefit the public with their experience."

"So much is applicable to forest officers, but we hope that forest officers will not be our only contributors; the scope of subjects

open to comment will no doubt enable district, settlement, railway, and engineer officers to give occasional assistance."

That we have retained the moral support of many forest officers now retired or who have only indirect links with the Indian Forest Service is shown in some of the messages of good will which we print below. We venture to hope that these proofs of our continued usefulness will spur the present generation of forest officers to contribute more freely to the pages of their service journal. With the further separation of the various provinces under the new constitution it becomes more than ever imperative that we should maintain the *Indian Forester* as our chief weapon against the menace of that narrow parochial outlook which has already made itself felt in certain quarters and which is the very antithesis of a sound forest policy.

THE FUTURE.

By Sir A. Rodger, O.B.E.

We, at the height, are ready to decline.
There is a tide in the affairs of men
Which, taken at the flood, leads on to fortune;
Omitted, all the voyage of their life
Is bound in shallows and in miseries.
On such a full sea are we now afloat;
And we must take the current when it serves,
Or lose our ventures! [*Julius Caesar, Act IV.*]

We, at the height, are ready to decline. Before the recent date when the world began to feel the full effects of the economic crisis, the Indian Forest Service had slowly but surely built up a first class property and a fine paying business for the state. Figures speak clearly. The surplus increased from sixteen lakhs of rupees in 1872 to two hundred and sixty-four lakhs in 1927, without any important falling away throughout that period. It is reasonable to expect that when world trade revives, as it has already showed

signs of doing, India and Burma will share in returning prosperity and the Forest Department may look forward to another era of profitable work.

But what of the Forest Department ? It can never be the same again. Facts must be faced. A great Indian service will be divided into a number of small services. It is too much to hope that the provisions of the White Paper will be substantially modified as far as the Forest Department is concerned, but it is instructive to quote, as illustrating the point of view of politicians, the following words from paragraph 56 :—

Sources of Revenue.	*Powers of Legislation.*
Forests and other Provincial Commercial undertakings.	Exclusively provincial.

So, we are a provincial commercial undertaking. It is true that, with one important exception, the Andaman Islands, the forests of British India are situated in, and the property of, the provinces. And rightly so. But there are other considerations. Will the plains of Bengal, the United Provinces and the Punjab have nothing to say to the welfare of the forests far away on the Himalayas ? Have we ever heard of destruction of forests on hills being followed by denudation of slopes and the laying waste of great areas of cultivation ? What is the best method of assuring a continuous and satisfying flow of water ? Is there to be no control from the Centre ? Let us consider this question from three points of view.

First,—The Welfare of the People.

Over large areas of many of the provinces the well-being of the more primitive races of dwellers in and near the forests is dependent to a very large extent on the proper and sympathetic administration of the forest areas. This administration reacts in a hundred ways, too many to describe here, but well known to forest officers, on the simple folk who know nothing whatever of Whitehall, Simla or Delhi. Their welfare is, and has been for many years, the especial care of forest officers who live and work with them. Certain of these races, or groups of races, are not confined to one province, and provincialisation will make their kindly administration much more difficult than

it is at present. Let us read paragraph 129 of Volume II of the Simon Report :—

"The responsibility of Parliament for the backward tracts will not be discharged merely by securing to them protection from exploitation................The principal duty of the administration is to educate these peoples to stand on their own feet, and this is a process which has scarcely begun................Co-ordination of activity and adequate funds are principally required........... The typical backward tract is a deficit area, and no provincial legislature is likely to possess either the will or the means to devote special attention to its particular requirements. Expenditure in the tracts does not benefit the areas from which elected representatives are returned................Moreover the most extensive tracts (if Burma be left out of account) fall within the poorest provinces. Only if responsibility for the backward tracts is entrusted to the centre, does it appear likely that it will be adequately discharged."

And, apart from the backward tracts, there are thousands of small, remote, inarticulate villages, whose welfare has always depended on good administration of the forests, following the enlightened policy laid down long ago by the Government of India.

Second,—The Development of Scientific Administration and Marketing, of Research and of Education.

The Government of India has always given the lead to the provinces in these matters. It has spared neither expense nor trouble in its endeavour to promote first rate work under all these heads, and, generally speaking, the provinces have been willing to accept the lead. Some have done a great deal and some very little, but the help and guidance have always been available, and the provinces have not been asked to contribute to the cost, except for the education of their own probationers for the gazetted and subordinate services. Consideration of this matter cannot be complete without reference to the service, which comes under the following head, but it is suitable to mention here the Secretariat of the Government of India and the Inspector General of Forests, who has

been also, since 1926, President of the Forest Research Institute and College. It is not clear how with provincial legislation entirely responsible for provincial commercial undertakings, the control and help of the Government of India is to be adequately utilised.

Modern silviculture, modern methods of marketing, up-to-date scientific research, and adequate forest education have been to a large extent organised by the Government of India, and no province can afford to do without their help, nor is any province capable of organising and carrying on these important branches of forest work as the Government of India has done.

Third,—The Service.

There are approximately 19,000 forest officers in India and Burma, of whom some 300 belonged up till 1922 to the Indian Forest Service, the remainder being provincial forest service officers and subordinates. About 1923, forests were transferred in two large provinces, Burma and Bombay. The first result in Bombay has been that the number of gazetted officers has diminished considerably, few or no recruits having been obtained for ten years.

This weakening of the controlling staff cannot fail to react unfavourably on the welfare of the forests. Burma is different. It has very valuable forests and has been accustomed to a very prosperous forest department. A new scale of pay and new rules for recruitment have been introduced, without reference to the needs of other provinces. What it will mean when this lead is followed and each province makes its own rules of every kind for the services can easily be imagined, especially as some of the provinces can only afford to have a small number of officers with very poor prospects of promotion. If Burma separates from India it will no longer be a factor affecting forest officers in India, but at present it does so, or would if normal recruitment were still effective. Every province is marking time during the long continued deliberations on the future of India, expecting that it will in due course be authorised to do what it likes with its own forest service, and the future of those services is indeed obscure if there is no central authority.

"And we must take the current when it serves,
Or lose our ventures."

Those of us who know the history of the Indian Forest Service and are proud of the part that it has played in the history of India during the last 80 years must recognise that the service is now faced with a crisis, and the only hope for the future would seem to lie in ignoring politics and the strife of tongues and in planning a reasonable and secure future. It cannot be that senior officers still serving will be satisfied to acquiesce in the entire provincialisation of the service. Every province will probably be allowed to do what it likes with its forests and its forest service but that is no reason why the advice and help of the Government of India in the management of this great *national* asset should not still be welcomed. I have already said that I believe that efficiency in research and education must decline if these are entirely provincialised, and there are other directions in which a central authority, call it a department at Simla, an Inspector General, a Board of Forestry, or what you will, would be of the utmost value. In the extremely important matter of the preparation of working plans several provinces are quite unskilled : adequate methods of marketing can undoubtedly be organised best by a central authority with the assistance of agents in London and elsewhere : the division into a dozen compartments of the forests which cover nearly one quarter of British India, and their management without any co-operation or co-ordination by a central authority, or any recognition of their value as a national asset, can only lead to deterioration and perhaps extinction.

Let us ask those members of our service who have still the right to guard the forests and express their opinions, to do their utmost to preserve this splendid inheritance for the people of India. This can surely be done by taking a broad view, and by adapting the lessons learnt in the past to the modern conditions to which we shall have to submit.

A YOUTHFUL GRANDMOTHER ; 1875—1934.

By Professor E. P. Stebbing, M.A., etc.

As I sit with the latest copy of the *Indian Forester* before me imagination carries me away to Darjeeling where, under the shadow of mighty Kinchenjunga, the infant *Indian Forester* was born: and endowed, it may be inferred, with some of the strength, some of the mystery, and, may it not be added, with some of the awe which encircles the virgin snow-clad peaks of this queen amongst mountain masses. For, from some aspects, it is with a feeling akin to awe that one looks back upon the long decades of life—a prosperous because a useful life—enjoyed by that tiny bantling whose birthday was celebrated by that great forester, Sir William Schlich, sixty years ago. Many journals and magazines, whose advent was heralded with great circumstance and pomp in the press of many cities of the world, who had at their back a certain capital to start them on a full course of life, have risen, achieved a briefer or longer activity, only to fade away ere they witnessed a jubilee.

The *Indian Forester* had none of these advantages at birth. Faith alone, and the loyalty of the department of whom she was the only child, a loyalty which, it must be admitted, waned at times, has enabled her to achieve her lusty age.

As one of her former honorary editors I have sat and mused as to the form an article on the present auspicious birthday should take. In glancing back through the fifty-nine volumes which portray her life it is easy to visualize the stages by which she has arrived at her sixtieth. But there is much that is not recorded in these volumes. What valuable material would have been extant had those early generations of Indian foresters who had been responsible for the inauguration of the department, then in its boyhood, but put on record the knowledge which they had wrested from the forests of their day. We know that at that time these forests teemed with big game—a hunter's paradise—and that the rifle was more familiar to their hands than the pen and far more frequently handled.

Scrappy records those early volumes do afford us—tantalising peeps into facts which must have appeared truisms at the time. But

the reply to a remonstrance from the Honorary Editor of the day 'I can't write ;—What's the good of asking me,' was still in vogue at a much later date than their time and with far less reason to back it.

But this being said, the record of the sixty years is surely an amazing one to look back upon—a veritable storehouse to delve into. For one thing, for the greater part of the period the magazine has appeared as a monthly. I wonder how many of its readers realise the work entailed in bringing out a monthly magazine ? Sitting in an editorial chair in a great city, even if the editorship is associated with other work, the editors of some of our great monthlies are, if they only knew it, in clover. I wonder what his attitude would be, could he but visualize its real significance, if one of these chiefs of a *corps d'elite* was suddenly landed with the *Indian Forester*. A perambulating honorary editor with duties taking him out into camp, touring round a province for months on end ; or, more latterly, perhaps through the length and breadth of India with perchance Burma thrown in.

I am tempted to tell a little tale, hitherto not disclosed, in order to indicate to our arm-chair editor the meaning underlying the above remark.

I had occupied the *Indian Forester* editorial circulating chair for some four years when, in the latter part of September, I set out on tour for Mussoorie, Chakrata, the Tons and the hills beyond. Since I was to be away some seven weeks my dâk arrangements had to be made with a meticulous care. I dropped my tour clerk at Deoban and set forth with the nearly completed MSS. for the monthly number of the *Indian Forester*, December to wit. I was expecting the last MSS. to complete it. Four marches further on it arrived and I halted two days to make up the number. A certain amount of pending work was also finished off ; and a somewhat large packet of dâk was packed and a special coolie obtained to take it back the first two marches where it would be picked up by a regular man and carried to Deoban. Some five interesting weeks passed before I rejoined my tour clerk at Deoban. Latterly I had been worrying about the non-appearance of the

proofs. On arrival I at once questioned the tour clerk. It took some time to work out dates accurately and the clerk then asseverated that he had never received the packet. I thought he must be mistaken, and setting some enquiries afoot we returned to Dehra. That was the time I walked from Deoban to Dehra *via* Mussoorie in a day (2-30 a.m. to 7 p.m.)—a glorious walk and wonderful day to look back on.

That packet was never seen again! A year later I heard the *dénouement*. The hill man who acted as dâk bearer (he could not be called 'runner') annoyed at being told off for the duty, had gone a few miles towards his destination and then, becoming more and more disgruntled, pitched the packet down the *khud* and returned home! It took three months and more to get the *Indian Forester* back to scheduled time; and an unending correspondence with authors! I shouldered the blame and put it down to my own gross carelessness, for the story itself was too incredible for belief. Moreover, though I had shrewd suspicions when I gradually recalled the morning on which I had despatched that packet, it was over a year before I had confirmation of the real truth. Other outcomes there were of that lost packet which cropped up at intervals during succeeding years.

The picture is there. A magazine which, in MSS. and proof form, marched about India and yet appeared if not regularly on the first of the month, yet with considerable regularity, can really boast of a hearty constitution. Naturally, only the past is referred to.

I refrain from glancing at some of the more notable of the articles its volumes enshrine (for I may be encroaching upon the present honorary editor's preserves, if I dwell upon that fascinating subject), it is permissible to draw attention to the great foresters whose names are found enrolled within its pages even though it would be impossible if not invidious to name them all.

To you, Members of the Service, with the magnificent position the great Indian forest estate has achieved, some of the work accomplished is the mere present day routine, which you accept as matters of everyday knowledge and procedure. But the past pages

of the magazine prove that the accepted principles were often preceded by the most violent conflict of opinion and were occasionally accounted as rank heresies. Perhaps one of the most important rôles the *Indian Forester* has played in the past has been that of a *Pioneer* and *Leader of Forlorn Hopes*. The shape which was eventually taken by the Research Institute at its inauguration had its birth in the *Indian Forester*, witness the leader in the number for January 1905. Many a lost cause, perhaps it would be a more correct designation to term them ideas of the most advanced type, and therefore to be regarded with grave suspicion, were first ventilated in the pages of the *Indian Forester*. For instance, fire protection in the Burma teak forests. In 1896 Mr. H. Slade, a brillant forester, wrote an article entitled "Too Much Fire Protection in Burma" (*Ind. For.*, May, 1896); Ribbentrop, Inspector General, took up the cudgels, summarized all the official information and the letters of May, July and August, 1896, in the *Indian Forester* and gave it as his confirmed opinion, based on his knowledge of the Burmese forests, that fire protection was as essential there as elsewhere in India. But the ball had been set rolling and a suspicion that all was not well had been born—witness the storm which raged round this question in the early years of the present century and its final settlement—for the time being at any rate.

Twenty years ago or thereabouts it was a commonly accepted opinion that little progress had been made in the study of Indian silviculture. Here again the pages of the magazine for, say, the first two decades of its life would appear to refute to some extent the contention. Groping in the dark as the officers of that period were, and with their hands full of the work now long since for the most part completed, there are many notes which provide food for thought. And some of the reports and inspection notes of Brandis and Ribbentrop teem with valuable silvicultural notes and suggestions, some of which display an intuitive insight into some of the problems which have worried the XXth Century silviculturist.

If the 59 volumes appear to fall short in one direction, it is on the subject of working plans. It is true that the great progress

made in this branch has been during the last three decades. But this progress is so marked, many of the plans are on a standard comparable with anything you can find in Europe, that it appears somewhat curious that no resumé of the work of any province has found its way into the magazine.

There is one last branch, one nearer home for me. Take Forest Entomology. Turn up the *Indian Foresters,* Vols. XXVI and XXVII and read Wroughton ("Ghati"), subsequently Inspector General of Forests, on the subject of 'Insect Enemies of Forests.' Then contrast the present position and the monumental work accomplished by Dr. Beeson, not forgetting the classic work on *Hoplocerambyx spinicornis.* When I read the modern Indian working plans I have now no feeling of surprise when I find Indian working plans officers glibly reeling off the fearsome names of this and other insect pests. But Wroughton and others poured ridicule on the idea of its ever proving possible to protect a forest in India from insects. By the way, another little story.

I believe that I was the first Indian forest officer to make the first full acquaintance of *Hoplocerambyx spinicornis.* It was down in the old Singhbhum division, in the part now forming the Saranda division. I had 3½ years' service. We were cutting broad-gauge *sal* sleepers on a Government contract for the Rae Bareilly Railway. It is true that the Assam-Bengal Railway ran through the Singbhum forests ; but, with the extraordinary methods in vogue at that (and present ?) time, that railway was laid with iron pot sleepers. On a hot morning in May I was passing sleepers with the railway engineer, Walton (two years my senior at Cooper's Hill), and he was rejecting what I considered a high average for what he called 'worm holes'—holes the size of a broad bean ! I was becoming considerably nettled—'Beetle holes,' I told him—'showed it was good sound wood.' 'Full of grubs,' he replied. 'Not at all,' I answered heatedly. The words were hardly out of my mouth when the coolies turned and let fall a sleeper. Out from a hole popped a large longicorn beetle with a 'squeak.' It was *Hoplocerambyx*—then, to me, unnamed, and totally unknown to the Indian Forest Department.

'There you are,' said Walton, 'Rejected'!

SOME ANNIVERSARY MESSAGES TO THE *INDIAN FORESTER*, 1875—1934.

Professor R. S. Troup, C.I.E., M.A., D.Sc., F.R.S., Director of the Imperial Forestry Institute, Oxford.

If there is one thing more than another that bears testimony to the progress and professional zeal of the Indian Forest Department, it is its departmental journal. As we scan its earlier pages, we find the names of men whom we knew and respected, but most of whom have passed hence, and we recognize the debt we owe to our forbears. Later come the years of active service when we claimed the hospitality of its pages to record our impressions and advance our views. And now comes the period when the present generation is playing its part, and those of us who have turned our faces towards the setting sun can mark the progress which the pages of the *Indian Forester* reveal. But while we all like to feel that we have furnished our small contribution to the advancement of Indian forestry, let us not forget what we owe to the Indian Forest Service itself. The value of the training and experience obtained in the service can perhaps best be appreciated by those of us who have subsequently taken up administrative or educational work elsewhere, for such experience is of more value, and carries more weight, than mere academic qualifications.

In the political changes which are impending a great responsibility lies on the forest officers of to-day and to-morrow; we look to them to maintain the high ideals of the Indian Forest Service, and long may the *Indian Forester* continue to voice these ideals.

Sir John Stirling-Maxwell, Bt., K.T., Chairman of the Empire Forestry Association and ex-Chairman of the British Forestry Commission.

The Honorary Editor asks me to contribute a note to the *Indian Forester* on the occasion of its 60th Anniversary shewing how far the forest service in Great Britain has been influenced by its elder sister in India. I welcome the chance of acknowledging the debt of British foresters to the Indian service.

It may surprise your readers to know that the home service only came into existence in 1920 partly as the result of the painful experience of the British Government during the war when the carriage of timber overseas was a most harrassing problem, and partly with the object of restocking the devastated woods and developing an industry calculated to stem the rapid flow of the population from country to town.

The objects and conditions are so different in the two countries that it never occurred to any one to model the new service on that of India, but nonetheless Indian foresters have had a profound influence on the movement. The generation of British foresters to whom the task fell of forming the new service had nearly all been trained under Sir William Schlich at Cooper's Hill or Oxford, or under Sir Isaac Bayley Balfour or Colonel F. Bailey in Edinburgh. These three remarkable men had all spent their best years in the Indian Service. They were not only thoroughly versed in the science of forestry, but had realized—as foresters have not always done—that the study of its local application is quite as important as the basic principles common to all countries. All three were delightful people, with the enthusiasm, kindness, modesty and charm which captivate the student's affection and make his work a pleasure. Apart from their regular students they had many disciples among owners of woodlands who sought their advice. So had Mr. W. R. Fisher of Cooper's Hill and Mr. J. Nisbet, who was Lecturer on Forestry in Glasgow. To these five retired Indian officers the renewed interest in forestry, which marked the closing years of the last century, owed its main stimulus and from their printed books and the published notes of Mr. Hobart Hampden and other Indian foresters it derived the bulk of its instruction. When towards the end of the war a policy of reconstruction was adopted, Sir William Schlich served on the Committee which formulated the forestry arrangements which are now in force. Sir William was then in his seventy-seventh year. As one of his colleagues of that Committee and more recently as Chairman of the Forestry Commission I have often had occasion to realize the soundness of the advice he gave. He had the rare type of mind which concentrates on things which are essential and in everything else is open to compromise. It was largely due to his advice that a policy was adopted which in practice has worked well and suffered little interruption even from the alternate extravagance and economy of the Government.

On the staff of the Commission there are four officers, Messrs. R. G. Broadwood, W. A. Muir, A. H. H. Ross and D. F. Stileman, who have served in India, and the Commission itself has no more useful member than Sir Hugh Murray who has been on it from the beginning, or a more distinguished recruit in Sir Alexander Rodger who was appointed a Commissioner last year.

This note will, I hope, suffice to shew how many points of contact there are between the two services and how beneficial the influence of Indian officers has been in this country.

Sir Hugh Watson, Timber Adviser to the High Commissioner for India.

It gives me great pleasure to send a message of congratulation to the *Indian Forester* on the occasion of its Diamond Jubilee. The journal has held its own nobly for sixty years, and throughout this period has faithfully reflected the trend of thought and the work of the Forest Department in India. Long may it continue to do so.

As a result of the economic depression which started in 1930 and unfortunately has not yet lifted, the Forest Departments of the Empire have been experiencing a most difficult period. In the past they were concerned mainly with the organisation and protection of the forest estate. The demand for timber expanded steadily and they could safely leave the commercial part of their duties to private enterprise. Owing to the depression there is a tendency to forget what they have done in the past towards protecting and organising the forests, and to judge them entirely from the commercial standpoint. There is also in parts of the Indian Empire a deplorable tendency towards a pessimistic attitude as regards the future of timber.

I do not for one moment hold that this pessimism is justified. When the depression lifts, the demands for the products of the forests are bound to increase, and while hard times may necessitate a temporary policy of retrenchment, any policy which contemplated a set-back in the protection and organisation of the forest estate would be shortsighted in the extreme.

In the future the Forest Department in India will have to devote greater attention to the commercial possibilities of its forests. The utilization branches should study carefully the imports and exports of timber and forest produce. All imports should be examined from the point of view of possible production in the country.

For example, India imports vast quantities of paper and considerable quantities of plywood. The materials for producing both these products are to be found in the forests of India. Similarly exports should be examined from the point of view of insuring a good standard of quality and a shape that will compete with competitors in the world's markets. The forest product that bulks largest in export value is lac, and it is generally exported in a comparatively crude and often adulterated state.

As in the case of past developments, the *Indian Forester* will no doubt play a leading part in the developments of the future. To this end it should devote more space to the study, analysing and criticism of imports and exports of wood and all products concerned with forestry in its widest sense.

J. B. Clements, Esq., B.Sc., Conservator of Forests, Nyasaland.

India's outstanding example and record in matters of forest policy have been of considerable influence in Nyasaland as they have in most parts of the Empire, and the long experience of the Indian Forest Service has undoubtedly been a most useful guiding factor in the evolution of forest policy and technique in the Protectorate.

In the first place all officers trained in the British forest schools obtain, during their training, a considerable knowledge of forestry in India, and this contact usually is greatly increased later by acquaintance with the excellent literature on forestry subjects by eminent members, past and present, of the Indian Forest Service; including that excellent periodical the *Indian Forester*, to which this department has subscribed for over 30 years.

The annual publications on Forest Research in India are of considerable value to this service for comparing methods and results with similar departmental research which is being carried out here.

A. H. Unwin, Esq., D.Occ., F.R.G.S., Conservator of Forests, Cyprus.

Ever since I began reading Schlich's "Manual of Forestry" in 1895, while still at school, I have taken a great interest in the development of the practice of forestry in India, Burma and the Andaman Islands. Early on, I had the honour and pleasure of being introduced to Sir Dietrich Brandis (really the founder of forestry in India) at Kew by Sir William Schlich. Whilst studying forestry at Tharandt, I had the honour and great pleasure of knowing Doctor J. Nisbet, who nearly 30 years ago, with his long experience

in India and especially Burma, was a most genial, gifted forestry guide, philosopher and friend to me in Tharandt and Munich. I also read Ribbentrop's "Forestry in India" with great interest and benefit.

In 1902, I first had the honour of being introduced to Sir William Schlich at Grafrath, and he was interested in the fact that I had studied for five years in Germany. Afterwards on each leave I kept in touch with him and gave lectures under his guidance in 1918 at Oxford. He was always most kindly appreciative of all work done, and inspiring me to do more. I owe a great deal to his work, and to his personal influence and kindness. I always consider myself very fortunate that I had the honour and great pleasure of serving under Mr. H. N. Thompson for over 13 years in Nigeria. His knowledge of both ground and technical forestry subjects was most profound and deep, and always being added to, through the constant reading of new books, which he presonally purchased on a most lavish scale. Mr. Thompson had been trained at Cooper's Hill and served 14 years in India before coming to Southern Nigeria in 1901.

I always felt that the foundations of forestry in India were very ably and firmly laid, mostly due to Lord Dalhousie's vision and Sir Di-trich Brandis' work over 80 years ago. It was as inspiration to feel that forestry administration in India was based firmly, as on a rock foundation, in a sea of unaccepted and unassimilated forest policies in other parts of the Colonies and Dominions.

To my mind there is no doubt that without this example of forestry administration in British India, progress in the practice of forestry in the various Colonies would have been much more difficult and very slow. Even now, when the profession of forestry is not recognised as it should be, considering its vital impotance to the real and constant welfare of any country, the example of highly developed forest administration in British India, Burma and the Andaman Islands and as in most of the Indian States, is a constant consfellation to which all may look for help and guidance.

SIR R. S. PEARSON, C.I.E., LL.D.

Permit me to send you a word of hearty congratulations on the occasion of the attainment by the *Indian Forester* of its Diamond

Jubilee. I well remember my father telling me of the anxious discussions they had in 1871-72, when he was officiating Inspector General of Forests, as to the advisability of launching such an enterprise and as to the scope and aim of the journal. We can now look back on the result of sixty years of endeavour, and without doubt the answer is 'yes.' Besides being a channel through which forest officers scattered over so wide an area as British India can exchange ideas on forest topics, the *Indian Forester* has been an inspiration to further effort to many of them. Above all, being a purely service publication, run entirely by officers of the Forest Service, it stands as a magnificent memorial to their energy and keenness. Much of the credit, not only for the success of the *Indian Forester*, but for that of the work of the Forest Service, must be given to the old pioneers, notably Sir Dietrich Brandis, Sir William Schlich, Colonels Pearson and Doveton, R. Ribbentrop, J. S. Gamble, R. C. Wroughton, J. Nisbet, H.C. Hill, T. H. Lace, Sir S. E. Wilmot, Sir Hugh Murray, and a host of others of the old brigade, who laid the work on sound foundations, and who set a high standard of *ésprit de corps*, which has been so admirably maintained by successive generations. As a training ground, the work of the Indian Forest Department is ideal, as it entails early individual responsibility, administering difficult and heavy charges with the knowledge that past generations have succeeded while to fail means disgrace. It is only necessary to look back on the records of many former forest officers as proof of the above assertion. It should not be supposed that the experience gained in the Indian Forest Service is only of value in India, far from it, as those of us who, after retirement, have been fortunate enough to obtain employment at home can testify and this should be a distinct encouragement to my comrades still serving in India.

Wishing the *Indian Forester* every prosperity and continued success in the future.

NEW ZEALAND FORESTRY'S DEBT TO INDIA.

By C. M. Smith, B.Sc.

Verbenaceae, Burmanniaceae, Pandanaceae, Santalaceae, Moniniaceae—the Indian forester who scans a flora of New Zealand forests to find families such as these, and genera which include

Dysoxylum. *Eugenia*, *Avicennia*, *Hibiscus*, *Litsaea*, to mention only five out of the eighty-two whose names have a distinctly Asiatic tang, might well expect that New Zealand forestry would find much to imitate from Eastern practice. There are, in fact, 28 families and 82 genera amongst New Zealand indigenous plants which constitute a "palaeotropic element" in the vegetation (1): and the great majority of the species concerned are species of the forest. They belong, one and all, to the sub-tropical rain forest, which is dwelt upon at such length by all writers on New Zealand forests, and which is perhaps over-stressed by the popular descriptive and often sentimental writer, who too often leaves the impression that New Zealand, prior to white settlement, was one vast sub-tropical forest. The natural forestry inference is that the soundest procedure would be to retain and to endeavour to perpetuate the sub-tropical forest type, and that in consequence, Indian forest experience should be of direct benefit to the New Zealand forester. This conclusion neglects several important factors of the local situation, of which may be cited :—

(1) The species which make up this "palaeotropic" or Austral-Malayan element in the flora are, with the exception of *Agathis australis* and *Dacrydium cupressinum*, of minor economic significance in the timber trade of the Dominion.

(2) This element of the flora is "in large part restricted to the warmer and frostless parts" of the Dominion. (1)

(3) In consequence the areas which originally carried stands of sub-tropical rain-forest have formed the bulk of the Dominion's farming-lands. The lands permanently dedicated to forestry thus came from what was originally either treeless grass-land or sub-antarctic rain-forest (*i.e.*, forest of *Nothofagus* species).

For these main reasons—and, in cases, for minor ones depending on such local factors as the presence of gold, coal, or ground game on such land—the silviculture of New Zealand has

adopted little or nothing from the experience of India in that type of forest which, at first glance, might have been expected to furnish a wide field for economic imitation.

Although failing to profit silviculturally from Indian precept and prior experience, the Dominion does, however, owe administrative debts to the elder service. In 1877, it borrowed for fourteen months, Captain J. Campbell-Walker, who prepared an admirable report, which is now of marked historic value to the technical forester. It is probably the only New Zealand forest document 55 years old which does not abound in over-statements. It was apparently intended to pave the way for the establishment of a Forest Service, but for reasons now obscure (possibly because there was a change of Government four months after the report was presented) Campbell-Walker was allowed to return to India and nothing more was heard of technical forestry for nineteen years.

Forty years later, in the years 1917—1920, vigorous publicity work by Sir David Hutchins, formerly of the Indian Forest Service, was a potent factor in the establishment of the present State Forest Service of the Dominion. The influence wielded by these two forest officers of Indian experience, although in one case the influence was delayed for forty years, is undoubtedly the greatest debt that New Zealand owes to the Indian Service. Linked with the above is the present-day less direct influence effected by the publications of the Indian Forest Service, particularly those from which can be gleaned details of departmental organisation and administrative methods. If it is not invidious to single one from many, mention may especially be made of H.G. Champion's recent Manual, a work invaluable to the isolated technical officer in search of analogies wherewith to fortify his arguments to an unsympathetic Comptroller of Treasury. This is admittedly a perverted use to make of a classic text book. It may soften the blow to the author (if in idle mood he scan these lines), to know that constant and legitimate reference is made to it, as it were in private, in the course of routine duty.

New Zealand has, for better or for worse, definitely specialised in exotic more than in indigenous forestry. Whatever be the

forester's personal opinion or predilections, he cannot ignore his half-million acres of pure exotic stands, which are already supplying some 15 million super feet per annum of saw timber. Not from the tropical rain-forests, but from the coniferous forests of the Himalayas, New Zealand has culled four exotic species, one of which may in the future hold a place amongst the successfully acclimatised forest species.

Cedrus deodara was an early introduction into the arboreta of the South Island (it is mentioned by Campbell-Walker in 1877 and recommended by him for further planting). As in Great Britain, it was usually planted as a specimen tree rather than in plantation form; and there are now excellently grown trees up to 70 years of age dotted in parks and around old homesteads. Possibly *Cedrus atlantica* is easier of cultivation here, and slightly more rapid of growth, especially in early years: but the Himalayan species handles quite easily in areas of good rainfall, and is fit to plant out as 1/1 stock, or 1/2 at most. Whether in the future it will ever be used on a large scale seems a little doubtful. After transplanting it is checked for a couple of years, and does not at once make the strong leader growth which enables the Californian exotics to outstrip the rank growth of bracken, gorse and other weeds. At present a small area at about 1,200 feet altitude in the vicinity of Nelson, on the cut-over edge of montane beech forest, is the only area under forest conditions owned by the State, and it promises well. If this proves to be a truly successful habitat, it may yet prove a very useful exotic species for the improvement of the non-commercial areas of beech forest on the foothills and mountains, although the hint in the *Indian Forester* of August 1933, as to its possible susceptibility to *Armillaria* damage strikes a warning note here. (2)

Picea morinda and *Pinus excelsa* are likewise old and successful arboricultural introductions. The pine, like the deodar, sets fertile seed in abundance. The spruce, during the last decade or more, has been remarkable for its freedom from the spruce aphis (*Neomyzaphis abietina*) which has ravaged all stands of both Norway

and Sitka spruce throughout the Dominion. Neither species is, however, likely to be used on a large scale.

Pinus longifolia has of recent years been tried on a very small scale. Some few specimens are growing fairly lustily in the Kauri belt (*i.e.*, north of 38° S. latitude) : but it is distinctly more difficult to establish than the pines of Southern U. S. A. (*P. palustris, P. caribaea, P. taeda*) which at present appear to show most promise for that district, and are very easy to handle.

The question of importations from Indian forests cannot be ended without a reference to another Indian forest denizen which has unfortunately been successfully introduced into New Zealand forests. The sambar deer (*Cervus unicolor*) was brought out in 1875 and at subsequent dates ([3]). This beast, which has, at any rate in its habits here, no sporting merit, has developed a palate for native timber trees ([4]), and is not above suspicion in exotic forests. Fortunately, there are but two well established colonies of it ; but owing to its skulking habit around swamps with heavy ground cover, it is not easy to eradicate, and one of these colonies is on the margin of the extensive Rotorua exotic forests. Regeneration measures, when the time for a second rotation arrives, will be none the easier for its presence.

There is perhaps some defence for Indian foresters with regard to this forest pest, in that such records as are available state that some at least of the importations were from Ceylon and not from India. This fact is but scant solace to the exasperated New Zealand forester, although it has the merit of enabling one of them to write that the New Zealand Forest Service has over a period of considerably more than half a century derived nothing but benefit from the far distant senior service of the Empire, and that all technical foresters are glad to acknowledge the inspiration drawn from its successes, its pertinacity, and its longevity in the face of the obstacles and perils that appear to beset every Empire forest service.

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([1]) Cockayne. *Vegetation of New Zealand* (2nd edition) page 414 (1928).

(2) Hole .. *Indian Forester* LIX 8, page 506 (1933).
(3) Donne .. *Game Animals of New Zealand* (1924).
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FORESTRY IN BRITISH MALAYA.

By J. P. Mead, Director of Forestry, F.M.S., and S.S.

British Malaya, as described in this note, has a total area of about 53,685 square miles and comprises, in the Peninsula, the Colony of the Straits Settlements, the Federated Malay States and the other Malay States under British protection and, in the north of Borneo, Brunei, a protected State.

The forests, which still occupy about 84 per cent of the total area, are all evergreen tropical rain forest and may be divided generally into the littoral forests and inland forests. Of the former the most important are the mangrove swamps, which cover between 300 and 400 square miles. The largest areas of mangrove are in the Straits of Malacca, on the coasts of Johore, Selangor and Perak and they have been intensively worked for many years for firewood, charcoal and poles. Of the inland forests the most important are the dry forests on the plains and up to an elevation of between 2,000 to 2,500 feet in the hills. From them is derived the main timber supply of the country. The high hill forests above this elevation are chiefly of value for purposes of protection and most of them in the more developed States bordering on the Straits of Malacca have been reserved for that purpose.

The earliest record of forestry in Malaya is a report of 1879 by the Colonial Engineer of the Straits Settlements on the timber forests of the Peninsula. It was mainly a description of the principal timber trees, but it also recommended the creation of a forest department. Little was effected however till 1883, when a small department was formed for the Straits Settlements under the Superintendent of the

Botanic Gardens, Singapore. This officer remained in charge until 1895, when the control of the forests was transferred to the Land Officers, an arrangement that continued till 1901. In the Federated Malay States there was practically no forest conservancy until much later.

It was not however till 1900 that anything really effective was done. In that year the late H. C. Hill, a Conservator in the I.F.S. was seconded to report on the forests of the Straits Settlements and Federated Malay States and to make recommendations for their future management. As a result of Hill's report the late A. M. Burn-Murdoch was transferred from Burma at the end of 1901 to take up the post of Chief Forest Officer (in 1904 the title of the appointment was changed to Conservator of Forests and in 1930 to Director of Forestry) of the Straits Settlements and Federated Malay States. The organization that he established, which closely followed the Indian model, has undergone little change to the present day.

Burn-Murdoch was severely handicapped throughout his service by shortage of supervisory staff, which at the time of his appointment consisted of four officers only, all untrained, and when he died in March 1914, had increased only to 13, of whom but six had received regular forestry training in Europe. Considering this handicap his achievements were notable. Forest legislation on the lines of the Burma Forest Act was passed, a small though real forest department with an *esprit de corps* was created, the working of the forests was brought under control, both as regards forest conservation and exploitation, and very considerable progress was made with the indispensable work of forest reservation, an area of 1,447 square miles having been created reserved forest at the time of his death. He also inaugurated silvicultural work on a proper basis, commenced the systematic exploration of the vast areas of virgin forest and made a small beginning with forest research, by starting a herbarium and by the establishment of sample-plots for the regular measurement of the commoner timber trees.

Burn-Murdoch was succeeded in 1915 by G. E. S. Cubitt, also an officer of the Indian Forest Service. On Cubitt's appointment his

supervisory staff consisted only of 14 officers, but as a result of his efforts, the department was greatly expanded, finally becoming in 1926 the Malayan Forest Service. At the present time, even after considerable retrenchment occasioned by financial stringency, the strength of the department is 37 serving officers. In 1915 and for many years afterwards the forest department supplied officers only to the Straits Settlements and the four Federated Malay States, but with the gradual recognition of the value of proper forest conservation, there are now trained officers of the Malayan Forest Service serving in the protected States of Brunei, Johore, Kedah and Kelantan. In fact there is now only one State that has no forest department, and this is solely owing to financial difficulties.

Cubitt created the existing Research Branch, which now consists of a well-equipped forest research institute with an excellent herbarium, a laboratory of wood-technology, timber impregnation plant, a chemical section and several hundred acres of experimental plantations. In connection with the institute there is also a vernacular forest school, in charge of a trained officer, where Malay subordinate officers are taught elementary forestry. Cubitt rapidly extended the area of reserved forest in the Federated Malay States from 1,893 square miles in 1915 to 6,271 square miles (or 22·5% of the area of the Federated Malay States) on his retirement. During his time revenue increased from $514,000 to $2,302,000 and expenditure from $324,000 to $1,671,000.

The present Deputy Director of Forestry, J. N. Oliphant, is a retired officer of the Indian Forest Service, who served many years in the United Provinces. He has been instrumental in introducing a number of improvements in administrative practice suggested by experience in Northern India, and has been primarily responsible for the initiation of the movement for developing an export trade in Malayan timbers to the United Kingdom.

Another officer with Indian experience is the Forest Engineer, Major W. F. Chipp, D.S.O., M.C., who served in the same capacity in the Punjab and Madras for 11 years. He has done much valuable

work during his three years in Malaya, principally in connection with the problems of sawmill production, seasoning and shipment of timber, and in improving methods of extraction; and the substantial progress made towards the development of the export trade to the United Kingdom is largely due to his mature experience and indefatigable labours in instructing the local mill industry how to produce material of the requisite high standard.

From these notes it will be apparent that the development of forestry in Malaya has been largely the work of officers trained in Indian forest service traditions and all members of the Malayan Forest Service are conscious of the debt we owe them.

FORESTRY IN TRINIDAD.

By R. C. Marshall, Conservator of Forests, Trinidad and Tobago.

The earliest connection between Trinidad and Tobago and the Indian Forest Service dates back to 1887 when at the request of the Secretary of State for the Colonies, E. M. D. Hooper of the Indian Forest Service visited and reported on several of the West Indian Islands. In his tour he included Tobago but did not visit Trinidad.

In 1900, however, F. Lodge of the Indian Forest Service was requested to visit and report on the forests of this Colony. He did so and wrote a valuable report. Forestry in Trinidad and Tobago may be said to have its origin in Lodge's report, one of the most valuable features of which was the indicating of a number of forest reserves and, most important of all, definite suggestions for establishing a forest service in the Colony.

This led in 1901 to the appointment of G. S. Rogers of the Indian Forest Service as the first Forest Officer in the Colony.

Regers put in 22 years' hard and profitable work till his retirement in 1923, his early years being largely engaged in the demarcation of forest reserves. He was also responsible for the Forest Ordinance

of 1901 which was modelled on the Burma Forest Ordinance, and, with various amendments, is still in force.

In 1913 teak seed was imported from the Conservator of Forests, Tenasserim Circle, Burma. From its first introduction teak has seemed very much at home, and plantations thereof are proving very successful. It is interesting to note that, as a rule, no difficulty at all is encountered in securing good germination of teak seed in the Colony. Plantations of this species now cover more than 1,000 acres and planting is being continued regularly.

Two other officers of the Department—H. W. Moor and L. F. Melizan—received their training in India, the latter being still with the Department.

The work of the Department has expanded steadily since its inception and whereas in the early days demarcation, forest protection, and the collection of revenue were its most important functions, of recent years, in addition to the above, regeneration operations, working plans, etc., have come more and more to the fore. Silviculture (including research), forest management and utilisation now occupy most of the time of the trained staff.

During the last few years a considerable amount of research work has been carried out on the regeneration of tropical rain forest and on forest soils—two inter-related questions. With regard to forest soil investigations, the Department has been fortunate in being able to work in conjunction with the Soil Department of the Imperial College of Tropical Agriculture.

The principal of this college is G. Evans, formerly Director of Agriculture in Bengal, and the Professor of Agriculture, R. Cecil Wood, formerly Director of the Agricultural College, Coimbatore. Both these officers have always taken a very live interest in the work of the Forest Department.

Apart from its connection with the Indian Forest Service, the Colony of Trinidad and Tobago is intimately connected with India as about one-third of the population is of East Indian origin. Following the abolition of slavery in 1834, planters in Trinidad experienced

great difficulty in securing labour to work their estates and in 1845 the system of indentured labour was brought into force. By this system immigrants were brought from India under guaranteed conditions with the option of returning after a period of years. Although a number have returned to India, the East Indian population of Trinidad has grown steadily, and now numbers therein many wealthy and influential members.

It may not be out of place, in concluding this brief note, to state that the writer thereof has recently been fortunate enough to receive a grant from the Trustees of the Carnegie Corporation of New York which will enable him to spend about six months visiting India and Burma early in 1934, thus maintaining a contact which commenced over 40 years ago.

TO BARA BANGHAL AND BACK.

BY TARZAN.

Not many miles from the glaciers which give rise to the Ravi river (one of the five big rivers from which the Punjab derives its name ; *panj*, five, and *ab*, river), lies the village of Bara Banghal. Cut off from the rest of the world by passes which vary in altitude from 9,000 feet to 19,000 feet, this part of the district had, so far as I could gather, escaped any form of official inspection since 1888. So it was more in the spirit of an adventurer than an interfering official that I laid down pen and pencil, took up gun and rifle and started for Bara Banghal, leaving my staff of " read up to matric's" and " failed B. A.'s " to cope as best they could with affairs of state. A perilous journey in a motor lorry, the frame-work of which was at angles undreamed of by the manufacturers and the brakes of which were a pleasant memory, ended at Baijnath, the last rest house on my route to Bara Banghal. The next day a short march of six miles brought me to Bir at the foot of the Salethar Pass, where a delightful camp in an oak forest with a small brook gurgling past my tent added to the joy of being off the hot, dusty, main road. A final

Photo A. M. David, I.F.S. The Ravi river at Bara Banghal.

sorting out took place here and I decided to leave behind the whole of my camp establishment except for my personal servant and one peon. I even had to jettison my beer because the route lay over very rugged and steep country and a small case of beer is, at the best of times, a luxury when tramping about in the Himalayas. My camp clerk called on the school master, an obliging young fellow, and made arrangements about the delivery of my mails by special runners. There would appear to be no connection between the two but there is ; the school master, in his spare time, is also the post master. With twenty stalwart coolies, each carrying light loads of forty pounds, we started off the following morning for Rajgonda, the first village over the Salethar Pass. We climbed gently for the first five or six miles through patches of oak forest and terraced fields and then came to the real business of the day when we entered the 4,000 feet pull up to the top of the pass. All vestige of a road had disappeared long ago and had been replaced by a goat track which zig-zagged across a long, narrow, shadeless spur. The sun beat down on my back and as I climbed I gradually divested myself of my clothes till decency prevented me from taking off any more. Half way up the spur there is a small hut with a muddy pool nearby to refresh the traveller, and some humourist must have had the naming of the place, for it is called *adia mar* which means 'half dead', a condition in which I arrived. The generally accepted meaning is that half the climb has been completed. The view from the top of this 10,000 foot pass is magnificent. One can see the fertile valley below stretching for miles on each side ; the small train winding its way in and out of the low hills like a noiseless clockwork toy ; and the tiny hamlets, with the sun glinting on the slate roofs of the houses, resembling dolls' palaces in some fairyland with silver threads for its rivers. A short and gentle descent took me to Rajgonda where my arrival was heralded by thunder and lightning followed by very cold rain. A few slats of wood against a rock and my mackintosh over the top provided some shelter from the driving rain till my tents arrived. When this meteorological demonstration was over, I crawled out of my hutch and ran into the infectious smile of Gulaba,

an old friend of mine and the only shikari in the district worthy of the name. Gulaba, derived from *gulaba*, a rose, is the strongest argument I have against the fallacious statement that "a rose by any other name would smell as sweet." In the hills the people are dirty, unkempt and somewhat primitive in habit and outlook, and the only thing that has saved them from extinction has been the inability of the plague, cholera, or enteric germ to survive the rigorous climatic conditions. When a child is born, it is given a bath: after that he (or she) bathes only when there has been a death in the village and I wondered how many years had elapsed since the last death in Rajgonda, Gulaba's village.

However, we soon got on to the subject nearest our heart for Gulaba is not like the majority of rapacious shikaris whose one aim and object in life is to mulct the sahib of hundreds of rupees in return for showing him a few impossible heads. Gulaba, who learned his trade from his very able father, took to shooting (more correctly poaching) when he was quite young and has to his credit well over a hundred black bears. Anyone who has seen these pests maul a pony or a cow till it is incapable of movement, and then start to feed on it while it is still alive, will have no sympathy for black bears. They will also attack human beings without provocation and destroy a whole field of maize in a single night. Gulaba drew up the plan of action, punctuating his description of the various shooting grounds with the silent, yet communicative action of raising his arms to hold an imaginary rifle, pulling the trigger, closing his eyes and dropping his head. In his three thick home-spun coats of goat hair, he was not unlike a black bear, and I gathered that the game was there just pining to be shot. Tender enquiries about his family elicited the fact that he had taken unto himself a third wife, the other two, like Napoleon's first wife, not having come up to scratch. With three wives in the house there could be no other profession for him than that of shikari; a profession which necessitates prolonged absence and no questions on return.

The following day Gulaba and I set off alone up the Uhl valley, leaving the tents and baggage to come along later. The path

ran more or less level through oak and spruce forests which swept down to the banks of the river. I opened my account by dropping a green pigeon as it flew out of an oak tree but I saw nothing else till a click from Gulaba's tongue made me stop and look round. Bounding up the hill through the forest and thick undergrowth was a musk deer. We waited till it was out of sight and then clambered up the hill after it silently but rapidly ; I, personally, never expecting to see more than its hind legs disappearing in the distance. But Gulaba as I have said before was (and probably still is) a poacher during his periods of unemployment, and as such, required no information on the habits of any game in his part of the world. He kept ahead of me and 'jumped' the deer again which moved off slowly. We both lost sight of it for some time but continued climbing till Gulaba pointed to a big spruce tree, at the base of which was a dark looking mass that might have been anything. Just then I very cleverly trod on a dry twig which went off like a pistol shot. The mass moved and I saw that it was the musk deer sitting down with its back to us. Nothing else was visible except part of its head so I fired where I thought the body ought to be. It wasn't. He was up like a flash but as he tore past us I exchanged rifle for gun and shot him through the neck with No. 4 shot. This usually timid little deer has no antlers, but the male (he is hardly worthy of the title of stag), is well equipped with long, curved eye-teeth which are sharp in point and edge and can inflict terrible wounds. He is poached from one end of India to the other for his musk pod ; a small fleshy sack under the skin on the stomach. This pod is dried in the sun and sold in the bazaars, the method of payment being the pod in one pan of the scales and gold in the other. Gulaba carefully removed the pod, pushed back the loose skin and sewed the whole lot on to the top of his woollen cap to dry in the sun. The deer he stuffed into his goat hair rucksack and once again we were on the move. Keeping to the high ground we came to a large, open, grassy slope which looked a likely place for monal pheasants, so I sent Gulaba up the hill through the forest while I walked slowly along the fringe of trees bordering the grassland. Presently they came, high birds with their wailing whistle

and I managed to add a brace of hens to the bag. About 1,200 feet below us on the edge of the stream I could see my camp and as that pot of tea was long overdue, I made for home and the cheerful blaze of the camp fire. A hot bath, early dinner and bed followed in rapid succession and next morning we were on our way to Paniartu, at the foot of the Thamseer Pass. The track got narrower and more difficult because the valley closes in here and is almost a gorge with high steep cliffs each side. Placing as much confidence as I dared in the nails of my boots, I stepped gingerly across the cliff faces, down loose shale beds and through more cliffs, humorously calculating how many times I should bounce before I hit the river some 700 feet below if I happened to slip off one of the ledges in the cliffs. The answer would have been, not once. Two miles from where we were to camp we were forced down into the nullah and had to pick our way over snow bridges and snow slides, parts of which had cracked and looked like gigantic slices of icing on a Christmas cake. It was very late and cold when we pitched our tents at about 10,500 feet. The river here broke up into several smaller streams each of them rising from one of the many glaciers which surrounded us. High massive mountains, turning from gold to rose pink and then to a chill grey as the sun got lower, frowned down at us. The top of the Thamseer Pass, 15,550 feet, which we had to assault on the morrow, seemed to present almost a vertical climb and looked very tiring and forbidding. Not long ago an Indian official called the *mal afsar* (revenue officer) who was on his way to Bara Banghal camped at this same spot, but when someone showed him the top of the pass he suddenly developed heart disease and insisted on being carried back to Rajgonda on a *charpoy*! We were camped well beyond the limit of tree growth and except for a few bits of scrub juniper there was no firewood. The icy wind coming off the mountain tops began to freeze everything and my little bull terrier pup soon discovered that the warmest place in the camp was *under* my blankets.

Gulaba, two spare men to carry my lunch, glasses and camera, and I left at six the next morning and started the climb to the top of the pass. Once again I began gradually to undress but this time,

as the morning was bitter I had on much more and was able to continue undressing for quite a long while. We had a short rest after the first 1,500 feet and then entered the vast stretch of moraine which terminated only at the summit where it lay hidden under deep snow. At 14,000 feet I reduced my speed because I found it somewhat difficult to get enough air into my lungs. But there, not very far away, was the pass. At last! It was the top but not our top; we were on a false crest! When we breasted this crest we came on to snow fields and large buttresses of snow clad rocks jutting out from the main range. I quickly donned my snow goggles, having once before had a touch of snow blindness, and put on a pair of snow shoes. This is merely a sack of knitted goat hair which slips over the leg up to the knee and has for its sole a grass shoe tied on like a Roman legging. One's feet may, and do, get wet and numbed, but there is never any fear of frost-bite. As I sat and smoked I counted six flocks of sheep and goats coming over the pass. These shepherds, called *gaddis*, are nomadic. In winter they take their flocks down to the plains and return again to their alpine pastures in the summer. A fine set of men beautifully built and cheerful, they have no roof except the heavens and no cares beyond their flocks. Their dress is also typical; the main item being a long, thick, and very full skirted goat hair coat which is pulled up at the waist and tied round with a goat hair rope about sixty feet long. The coat then looks like a short kilt and the rope serves no other purpose than that of a support for the back. Peeping out from inside their coats one invariably sees two or three small white heads of newly born lambs and kids, which are kept generously warm and free from fatigue till they are old enough to fend for themselves.

The *gaddis* all had the same tale to tell and implored me to deal heavily with some of the more notorious brown bears which had turned sheep killers. The snow or brown Himalayan bear is not nearly so dangerous or truculent as the more common black bear, but when it turns a sheep killer it is ruthlessly destructive; slinking into the sheep pens at night and killing a dozen at a time for no apparent reason. Making a note of the nullahs in which these bears

lived we hurried on because we still had a long way to go. The baggage coolies crawled up to the top of the pass after us, threw off their loads and with joined hands touching their foreheads paid homage to the various peaks on which were supposed to dwell dieties of local importance, no doubt frozen to death by now. With tinder and flint willing hands prepared *hookas* while the remainder burst into song, sat down in the snow, produced a pack of cards and indulged in some very high spirited gambling. Then began the descent to our next camp over moraine, along the edge of glacial lakes, across stony "chutes" and finally on to soft and restful grass land. It was seven o'clock at night by the time the tents were pitched and I was so tired that I forgot hunger and jumped into bed with a large cup of cocoa inside me, much to the annoyance of my servant who, in some mysterious manner, had produced a five-course dinner. There was every excuse for our fatigue as we had been on the go for nearly thirteen hours at an altitude of over 10,000 feet. An easy but rough descent the next day brought us to Bara Banghal, a picturesque little village perched on the lower slopes of a broad rocky bluff and housing some 450 souls. The Ravi, at this point about 30 feet across, hurried on its way down to the plains and the blue pine, cedar and spruce clad mountain sides with high snow peaks for a background provided a subject more suited to the artist's brush than the journalist's pen.

Practically every spruce tree had been barked to provide tanning material for goat skins in which the people store water during the very severe and prolonged winter. Earthen vessels are perfectly useless as they crack when the water freezes at night.

I made my camp in a long, narrow, strip of cedar forest and when we had settled in, Gulaba asked permission to go to the village to have a drink. This meant a Gulaba with a thick head in the morning but hillmen, and particularly *gaddis*, cannot resist a quart or two of *lugri*, the local home-brew ; a poisonous beverage which smells of methylated spirits, tastes of turpentine, and produces a sort of stupor very akin to a drug. I let him go because he would have gone even if I had withheld permission ! At Bara Banghal I took on a fresh lot of coolies and started up the Ravi valley, turning up

On the Thamseer Pass.

Photos : A. M. David. Brown Bear.

into the Sha Nal after I had covered about three miles. This nullah rises rapidly and by four o'clock in the afternoon we found ourselves at the snout of a glacier, having traversed all the bear ground on the right bank. Every patch of grass which held promise of succulent edible roots, chiefly the wild carrot, had been dug up but most of the excavations were a week or more old. I saw nothing except some high flying snow pigeon and returned to camp empty-handed. The brown bears were there right enough but they were moving about from one place to another and had not settled down to one feeding ground for any length of time. The next day I sent the camp down the nullah while Gulaba and I crept away before dawn in the hope of coming across a brown bear returning home. We drew blank and settled down under a solitary tree from where we could observe several of the feeding grounds. I gladly dropped off to sleep after a picnic lunch, during which Gulaba had disappeared on his own to look elsewhere. When I awoke I looked across from the knoll on which I was sitting and on the edge of a fir forest I saw a rock that I did not remember seeing before; I had scanned this open glade very carefully with my glasses and knew it well. Suddenly the rock began to move and kept on moving! A quick peep through the glasses showed that it was a fine brown bear. The time was 6 p.m., Gulaba had vanished and to get anywhere near the bear we would have to drop down 1,200 feet to the stream and scramble up 1,000 feet the other side. Gulaba, wherever he had been, was not long in spotting the bear for he came tumbling down the hill-side, picked up my rifle and glasses and, with a nod towards the bear, beckoned to me to follow him. We slid down the grass slope in about nine minutes, but it was long enough to enable me to leave several important parts of my shorts and shirt festooned on the landscape. We climbed up the other side and when we entered the forest we shed our footwear and avoided twigs as if they were snakes. Ten minutes later we crawled along a small hollow and when I looked over, the bear was not 30 yards from me, grubbing up all manner of roots. Excitement overcame experience and I raised my rifle and fired without giving my thumping heart time to return to its normal action. The result was

that I hit the bear through his left elbow. With a howl he stood up, presenting a much larger target of which I took full advantage by placing my second shot through his chest. Between us we rough skinned him and with Gulaba carrying the blood-sodden pelt we made a triumphant entry into camp at 8-30 p.m. Fortunately there was no village handy for Gulaba to celebrate the event in *lugri*, but as recompense I poured a couple of neat double whiskies down his throat and received his gratitude to the extent that "it was nice but not enough."

Morning found us on the same knoll but as there was no sign of any game, I decided to walk up another small nullah at the top end of which Gulaba said he had seen ibex earlier in the year. I was strolling along leisurely not really looking for anything when my attention was drawn to the low cliffs on my right, 80 yards away. On a ledge low down in the cliff were three brown bears, a female with two full grown cubs to heel, on their way home to some deep cave among the enormous, jumbled pile of rocks. Unfortunately they saw us and made rapidly for some bushes. I very foolishly had a shot at the big female and missed, at which the family took fright and disappeared only to come into view again lower down on a spur 50 yards from us. Gulaba, who was carrying my gun and seemed to have very little faith in my marksmanship, felt he ought to do something, so he stood up straight in front of me and levelled my gun at the leading bear just as I was about to pull the trigger of my rifle. I suppose there is a Providence which watches over other similar idiots but the three Mrs. Gulabas were never nearer to being widowed, for there would have been very little left to take home if I had put a ·333 Jeffery Magnum bullet through Gulaba's neck at two yards! The three bears promptly turned, retraced their steps, and broke into a gallop over the open ground behind us. I simply could not shoot straight for laughing. They looked so absurd and grotesque; like some pantomime bear whose back legs had been shoved into a pair of over-size trousers. However, this was not the time for laughter so I steadied myself against a rock and with my third shot I dropped the big she-bear in her tracks. I gave up the quest

for ibex because had there been any in the cliffs above and beyond, they would certainly not have waited to see what sort of rifle I was using. Gulaba soon had a fire going and by its welcome warmth we removed the skin and most of the fat ; a very messy job. A gift of bear fat is very highly prized by the Indian, who finds in it certain medicinal properties which he claims will cure rheumatism. There was nothing to be gained by staying out so we returned to camp with the spoils of the chase, and while the coolies admired the gory skin and covetously eyed the bear fat, I lay down in the sun and slept like a log until tea time when I awoke, refreshed and quite ready to help with the bear skins which had been pegged out in the shade and were even now being carefully and neatly cleaned by Gulaba.

The advent of another day saw us retreating down the nullah through patches of birch and rhododendron and dense forests of fir and blue pine, in which some modern Orpheus, concealed among the stately stems, emitted a limited number of soft watery notes from his bamboo pipe. Shortly before noon we struck the Ravi and turned upstream along a very narrow path which hugged the bank of the river and ran just above its bubbling and turbulent waters. The sites for a camping ground were neither large nor varied because the river had carved its bed out of solid rock, outcrops of which extended far up each bank. However, we made a temporary camp for the night as best we could and with plenty of wood to keep the fires going and our blood from freezing we were reasonably comfortable. The following day we pushed on up the valley till once again we were beyond the limit of tree growth when, suddenly and without very much warning, the weather broke and we were caught in a snow storm. We espied a *gaddi* hut, a rough stone affair rather like a large hollow cairn, at the bifurcation of the Ravi about a mile away, and made for it, crawling inside and taking what little shelter it had to offer from driven snow. Gulaba collected some scrub juniper and lit a fire in which he roasted and ate, with much crunching of bones, a red dove I had shot for him. The bedraggled baggage coolies arrived three hours later, cold and numbed, and clustered round the fire which was mostly smoke and very little flame,

When they had infused some warmth into their fingers we set about pitching the tents ; a task made doubly difficult by the intense cold and a high wind. It snowed all that night and the next day, but nothing daunted, Gulaba and I went out in the afternoon to look for ibex as the storm showed signs of abating. The higher ground had had a good dusting of snow and should have driven the ibex down a few hundred feet. Staring up at the cliffs we had no interest elsewhere till we almost walked into a brown bear which was so engrossed in its digging that it neither scented us nor heard our light foot-falls on the soft grass. He was one of the solitary bears which had killed many sheep that year and we found him exactly where the *gaddis* told us they had last seen him. There was nothing for it but to shoot this sheep killer so I lay down on a convenient rock and bowled him over with a single shot through his neck. There remained the precipitous ground in the main valley and this we visited the following day, climbing up to 14,000 feet so as to get well above the ibex because, like all other wild sheep and goats, they never expect danger from that quarter. The rounded hillocks of grass and rock were full of snow cock and I was lucky enough to put up a large covey out of which I took a right and left as they dived down hill. These birds are very difficult to flush for they invariably waddle uphill keeping just out of range and knowing that heart failure will prevent you ever getting up to them. In the fresh snow we picked up tracks of ibex but as they were nowhere to be seen, we dropped down to the river and selected a suitable spot from which we quartered the cliffs with our glasses. I was hoping to see a few bucks by themselves and the main herd much lower down, as it was still too early in the year for the rut and until then the really big bucks are on their own. We had a spare man with us, a gaunt *gaddi* from Bara Banghal, and it was he who, without any artificial aid, spotted a herd of ibex which it took me several minutes to locate with my glasses. In a fold of the hill where the grass was yet green the herd was feeding peacefully and showed no inclination to move far. Two well placed females doing duty as sentries guarded all the lower approaches ; a characteristic precaution taken by ibex and

baral (the wild blue sheep). I watched the herd for a long time and saw only one shootable buck which hove into sight when I had almost given up hope of seeing a mature head. Leaving the spare man to signal to us the movements of the herd, Gulaba and I crossed the stream and wearily climbed up some dead ground on our left. When I thought we were level with the herd I started to traverse the face of the hill and, after missing many heart beats as a result of treading on loose stones, I arrived on a small promontory 200 yards from the herd. The lay of the ground made it impossible to get nearer. My glasses revealed a herd of sixteen ibex with no big head among them except the one I had already marked down, and when I had picked him out I kept as steady as I could at that altitude and pulled the trigger of my rifle. I hit him but not mortally. The reverberations of the shot had hardly ceased when four fine bucks came out of a hollow 600 feet above us. None of us had seen them till then but they were off like a string of Derby candidates before I had recovered from the surprise. The herd lower down had also stampeded but the buck which I had hit went a short way into the cliffs and jumped on to a ledge where he stood and stared at me from 350 yards. He crumpled up with my second shot and lay motionless on the ledge. The place looked impossible to get at but Gulaba determined to do his best and left me. When I last saw him he was not far from the buck and was clinging to insecure pieces of rock on absolutely sheer ground. I could watch him no longer and closed my eyes, but not before whistling him up and waving him off. To me it looked certain death to venture any further down the cliff face. We left the ibex there and next morning a gang of my baggage coolies, by means of ropes and much scrambling, managed to kick him off the ledge. He fell the 1,000 feet to the river without touching anything except a sharp projecting rock which snapped off his horns and sent them humming through the air, never to be seen again. The carcass was broken up and brought back to camp where it was divided amongst all (I gladly gave up my share) and greedily devoured.

Taking a last look at the Ravi glaciers and nodding a grateful thanks to the hill gods we marched back to Bara Banghal in one day, Gulaba estimating the distance as "seven long smokes." Next to drink the *gaddi* loves his tobacco and on the average he sits down to a *hooka* once every mile. We were all glad to get back and Gulaba, after he had seen to the field curing of the skins, left hurriedly for the village to keep an overdue appointment with a bottle. I devoted one day to listening to the grievances of the villagers and unravelled all their knotty problems for them. The band turned out for my benefit and acted as escort to a terrified sheep which was presented to me by the headman on behalf of the people. In return I gave them some deodar trees on behalf of Government so that they could repair their one and only bridge over the river. We parted the best of friends. I had to return in a hurry the same way that I had come because my chief altered his tour programme which made it necessary to curtail mine. I, therefore, reluctantly abandoned my proposed expedition after tahr, the wild goat, in some vicious looking cliffs above Bara Banghal. The change was so rapid that I hardly realised I was back in Baijnath and comparative civilisation where I met my very excellent chief and his wife who, somewhat tired of driving themselves about in a car on the tortuous hill roads, handed the wheel of their Austin over to me. How far were the two apart: an Austin and Bara Banghal! It is a grand country unspoilt by man, and in these days of White Papers and Red Beliefs one must thank God for having encircled it with mountains over which no Congress foot will ever have the energy to tread.

A LARGE STRYCHNOS NUX-VOMICA TREE.

BY M. V. LAURIE, M.A., I.F.S.

The photograph shows an unusually large *Strychnos nux-vomica* tree which is probably a record. It is 110 feet high and has a girth of 11 feet 5½ inches at 4 feet 6 inches from the ground.

This species is usually found in deciduous forest of a rather dry type, where it is a small rather branchy deciduous tree dropping its

Strychnos nux-vomica large tree growing in open. Girth 11′—5½″. Height 110 feet.

Kittu's Darkhast, Someshwar.
North Mangalore Division, Madras.

Photo : M. V. Laurie.

leaves for a short time during the hot weather. It also occurs in moist deciduous forest where it attains a fairly large size, and is evergreen and shade bearing in character, growing frequently under fairly dense shade. It is often found for instance growing in the teak plantations at Nilambur where it has come in naturally under the shade of the teak.

The tree photographed is in a clearing surrounded by semi-evergreen forest at the foot of the Western ghats in North Mangalore division, where the rainfall is probably about 200 inches per annum. The underlying rock is laterite and the soil a clayey loam. Although it is not common in such conditions, it appears to thrive in them and attain a great size.

The seeds form an important article of minor forest produce, especially in the drier types of forest where it fruits abundantly every year. The fruits are like small oranges, and contain a pulp in which several round flat seeds are embedded. The seeds contain a high concentration of strychnine and are very poisonous. The pulp of the fruit also contains some of the alkaloid and is very bitter, but in spite of this it is eaten by langur monkeys and by the Malabar hornbill (*Anthracoceros coronatus*).

The wood is hard and durable, and is not eaten by white-ants probably on account of its bitterness. It is, however, not much used.

JOINTS USED IN TIMBER FRAMING.

BY L. N. SEAMAN, M.A., B.SC., M.E.I.C., OFFICER IN CHARGE, TIMBER TESTING SECTION, F.R.I.

A very interesting and useful publication, entitled: "Modern Connectors for Timber Construction" has recently been issued by the United States Forest Products Laboratory (price 15 cents from the Supdt. of Documents, Washington, D. C.). It outlines the history of the gradually increasing importance of timber construction of recent years particularly in Europe since the war, and then proceeds to study the efficiency of joint fastenings utilized in modern practice.

Some of the points covered should be of particular interest in India, where timber construction has always held a place of importance.

Necessity, the mother of invention, stimulated the improvement of timber joints in Europe when wood was still so plentiful in the United States that wasteful, inefficient joints were not considered a serious defect. In this country the point has not yet attracted serious attention, but on every side may be seen timbers of most inefficient proportions joined together in structures in a way which fails to utilize even a fraction of their strength. It will be well for us in India to take advantage of the work done in America in the cause of improved timber construction.

At the outset it should be recognized that the joints have always been acknowledged to be the weakest points in timber structures. While it is not impossible to produce efficient, well balanced joints by the use of ordinary bolts, keys, dowels, screws, or even spikes, it is very rarely done, and when done, the result is bulky and often unsightly. Even the so-called standard joints employed in some instances are lamentably weak in comparison with the rest of the structure in which they occur.

Long ago it was the carpenter's craft to produce elaborate, complicated wooden joints in the erroneous belief that, by much difficult cutting and laborious fitting, he was constructing a joint that was strong and efficient. In time this tedious and wasteful practice gave place to the simpler, but at the same time more efficient bolted joint. Now modern requirements have developed connectors superior to any of the devices formerly employed. Those available are not all suitable for Indian conditions, labour, or indigenous species of timber, but the data collected at Madison will serve as a valuable starting point, and, pending the opportunity for tests in India, will point the way for improved construction with timber, by using joints that are at once better and cheaper.

The National Committee on Wood Utilization in the United States collected data on 60 types of connectors, both wood and metal, many of which are of commerical importance. The United States

Forest Products Laboratory then conducted tests on the most promising, the results of which indicated that no one connector can be selected as the best for all conditions and all species of timber. The characteristics of each can be classified and safe working loads assigned. Thereafter the selection of the most suitable for any particular job must be a matter for engineering judgment. These data from America cannot solve the problem for India, but can be used as a tentative guide till we are able to do our own testing, and select, or possibly improve, existing designs for application to our own timber species and conditions.

To quote from the Madison publication, "Connectors consist of metal tubes, rings or plates, or wooden disks or keys, which, embedded partly in each member, transmit load from one structural part to another." India requires connectors suitable for woods which are much harder and stronger than those commonly used in either Europe or America. They must also generally be usable by less skilled labour, and usually, for the present at least, without special machine preparation of the timber.

The application of modern timber connectors in Europe and America has already resulted in the use of wood for structures which, a few years ago, would certainly be built of steel. To cite only a few examples mention may be made of "... numerous radio towers, one of which is 460 feet high, bridges more than 1,000 feet long, an auditorium with seating capacity for 75,000 persons, modern piers, railroad stations and locomotive shops, warehouses, churches, and airplane hangars" (page 2). In Europe the experimental stage has passed, and, by the use of modern connectors, wood has assumed a new structural importance.

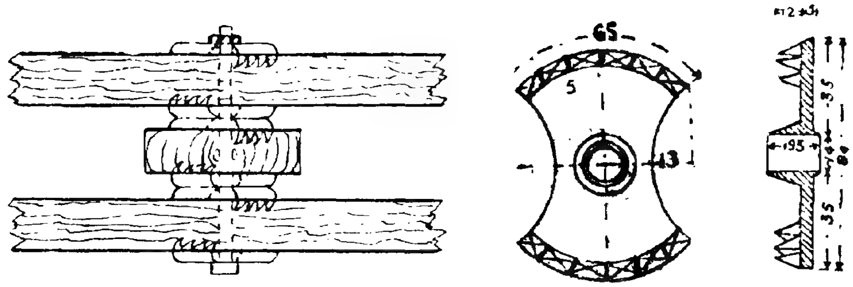
One advantage of modern connectors is that, besides affording an efficient means of making much stronger joints than were obtainable by older methods, they are ideally suited for the assembly of structures built up of boards or planks instead of using large solid timbers. Their use, moreover, often eliminates eccentric joint connections with their resultant secondary stresses, and the designer

can be assured that each framing member will function as a true two-force piece. With suitable connectors the number of bolts can be reduced with consequent gain in net cross section of the timber and less weight in the entire joint. Connectors are also especially suitable for factory fabrication, but this is an advantage more apparent in Europe and America, for the present at least, than in this country.

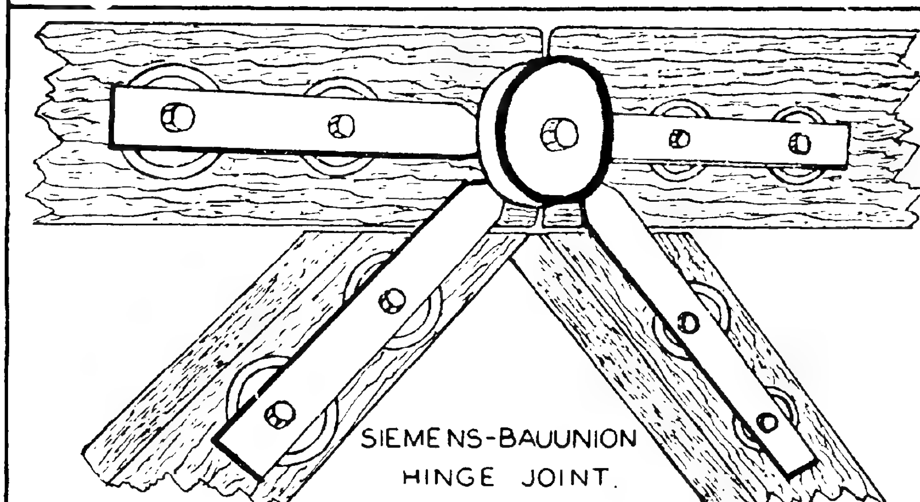
The simple bolt acts to hold the two members of a joint in close contact, and to prevent them from slipping past each other. It is thus subjected to tension, shear, compression and bending. The bending stresses are most severe at the surfaces of contact of the timbers, where their intensities are much greater than the average. Modern connectors have grown out of an effort to relieve these concentrated stresses by the introduction of bushings, or "half dowels," at the positions of their greatest intensity.

In all joints of wooden structures some slip occurs, and the amount of slip to be tolerated is not definite, but should not be excessive. Some authorities tolerate a slip of only 0·04″ at the limit of proportionality of slip to load while others admit as much as 0·08″. Accepted safety factors for joints vary from 2·5 to 4, the general tendency being to use smaller factors in Europe than in America.

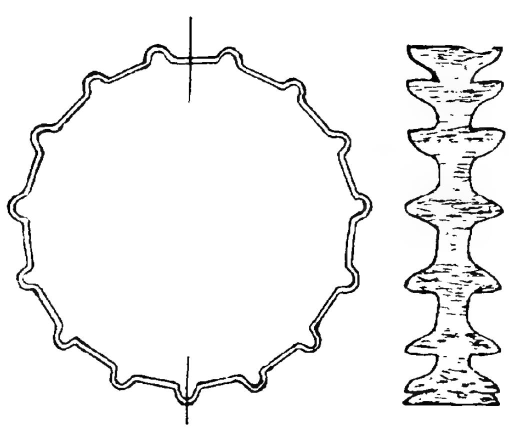
Results of tests carried out upon joints of timber are now available from both Europe and America, and may be used as a rough guide in the design of timber structures in India till it is possible to conduct proper tests in this country, by combining them with the results of timber tests already available at Dehra Dun. But just as it was found that the results of European tests were not wholly satisfactory for use in America, so also it would be unwise to rely only on foreign results in India. The class of labour is different, and the strength and hardness of Indian woods are greater than are commonly found abroad. It will be wise, therefore, to depend on foreign data only until time and funds are available to justify our own tests, and possibly also to devise a new type of connector especially suitable for Indian conditions.



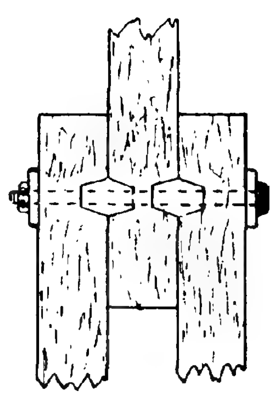
GREIM CLAW PLATE, (SIEMENS-BAUUNION)



SIEMENS-BAUUNION HINGE JOINT.



ALLIGATOR RING DOWEL



KÜBLER DOWEL

The connectors dealt with in the report of the American Forest Products Laboratory comprise the following types :—

1. Keys, and simple shapes of metal plates.
2. Cast or punched plates or dowels with teeth, rings, or other projections to engage the wood.
3. Ring dowels, closed and split.
4. Disk and coned dowels.

It is unnecessary to discuss the use of keys at this time, whether in the form of wooden blocks, or metal strips, flats, angles or tees. This idea is not new, and joints of this kind will offer no design difficulty to engineers if the strength values of the materials employed are known. Suffice it to say that these can be used to improve the efficiency of timber joints when better connectors are not available, but when used should be carefully fitted to ensure proper bearings, particularly when the load is to be taken by a number of keys in a single joint.

The development of plate dowels was a natural evolution from ordinary keyed joints. The cast iron ring plate and the steel punched plate were predecessors of this connector in its modern form, and were used in America before 1890. It has probably reached its highest development up to the present time in the various forms of the Siemens-Bauunion connectors, examples of which are the male and female claw plates for the smaller joints, and the hinge joints for heavy solid timbers in large structures. (Plate 13.) These devices distribute the load so that few bolts are needed and remove all eccentric stresses in the component members. They possess the added advantage of no small importance in the Indian climate, that joints made with green timber are equally strong after shrinkage as those made of timber which has been seasoned. The snug fit resulting from the shrinkage of the wood is found to offset any damage that it may have suffered in the seasoning. Tests in Europe indicated that joints made with these connectors suffered, at moderate loads, less than one quarter the slip found in bolted joints, and that they possessed more than three times the strength of the latter. Their

disadvantage for use in India, however, lies in the fact that they require very careful fitting, and that the timber members should be prepared with a special drill which recesses for the plate and teeth and bores the bolt hole in a single operation to ensure exact centring and a good fit.

Another example of plate dowels is the Bulldog plate connector, invented in Norway, and largely used in Scandinavian and other European countries. It consists simply of a steel plate with teeth pressed up on both faces to engage the timber. The plate is placed between the members, which are then forced together till the teeth on both faces are fully embedded in the wood, when the whole is held by a bolt through the centre of the assembly. Trials are necessary to determine whether or not the teeth on the commercial pattern of this connector are sturdy enough to force their way, undamaged, into Indian hardwoods such as *sal,* and to estimate its efficiency with the harder indigenous species. Data available from Europe and America assure its suitability for structures of deodar, *chir,* spruce, fir, and other Indian conifers.

Bulldog connectors are made in various sizes and shapes, with safe working loads per connector assigned in each case, and a special oval design is supplied for use with rough, unsquared logs. They are not, however, immune to the weakening effect of seasoning on joints assembled in the green condition, and tests proved such joints to have little more than half the normal strength when the load acted along the grain, and three-quarters when the load acted perpendicular to the grain of the wood.

Another type of plate dowel, the Bufo friction plate, was found to make joints which suffered seriously in strength when shrinkage occurred in the timber members, and consequently it is not likely to prove satisfactory for use in the climate of India.

Still another form allied to the plate dowel is the G. S. spike connector. It consists of a number of cast teeth connected by bars, which act in a manner somewhat similar to the pressed teeth of the Bulldog connector. Tests are necessary to determine whether or not

this device is capable of standing up to work with the harder Indian species, but results available from abroad indicate that, while suitable for use with our softer conifers, improvement in design, material, or both design and material would be necessary to fit it for use with most Indian woods. The efficiency of this connector, also, is rather affected by shrinkage of the joint members, though not fatally so, joints made green and then seasoned having about two-thirds the strength of those made of seasoned wood. One objection to the use of this connector in India is the great force necessary to embed the spikes properly in the wood.

Ring dowels form efficient connectors when machine preparation of the timbers is possible, as the grooves for the rings must be accurately cut. Essentially these connectors may be likened to very short lengths of pipe embedded for half their length in each of the two pieces connected, the whole being held by a bolt through the middle. Load transmitted from one member to the other has a tendency to turn over the dowel, which, in order satisfactorily to resist this overturning moment, should have a diameter about five times its length. There are several modifications of the ring dowel, but perhaps the one most promising for use in India is the Alligator connector, which is a sheet steel toothed ring. (Plate 13.) This, like other connectors which are meant to be embedded in the wood by pressure, must be tested for its ability to stand up to Indian woods, and for the amount of pressure necessary to use with some of our harder species. Shrinkage of the timbers used in the joint, however, has a serious effect with this connector, in some cases reducing the strength by nearly half.

Split ring dowels, *i.e.*, ring dowels that are cut through at some point in their circumference, have been found more efficient than solid rings. This is because the latter, due to difficulty in fitting and to shrinkage of the wood, cannot make satisfactory use of the bearing and shear areas of both the core within the ring and the wood outside the groove at the same time. The flexibility of the cut ring permits an improvement in this respect. It offers the same

difficulties, however, in the preparation of the joint members as the solid ring.

There remain for consideration the disk and coned dowels, solid except for the bolt holes, and made of either metal or wood. One of the most striking examples of their use is found in radio towers, notably the 330 foot self-supporting wooden towers at Stuttgart. It is claimed that by using timber towers, brass bolts, and oak dowels an extremely high radio efficiency is obtained. These dowels have also been satisfactorily used in many other important structures, including the 3-hinged arches of 85 foot span in the salt storage shed at Hanover. One type, the Kübler dowel, was originally made of cast iron, but since 1927 oak has been much preferred. (Plate 13.) Some of our Indian species, with their great hardness and high resistance to splitting, should be expected to make even better dowels than oak.

These dowels are made with a slightly greater diameter at the middle and tapering towards the ends, for ease of insertion and tightness of fit. They are commonly used with $\frac{1}{2}''$ bolts, which are meant only to hold the parts together, the transmission of load being dependent on the dowel itself. The grain of wooden dowels should run diametrically across them, not along their length, and, when possible, should be placed in the joint parallel to the grain of the connected members.

The safe load recommended by the United States Forest Products Laboratory for oak dowels $2\frac{1}{2}''$ in diameter with half inch bolts in Douglas fir structures, when the load bears on the end grain, is 3,300 lbs. per pair of dowels. For a pair of 4″ dowels similarly used the recommended safe load is 7,500 lbs. It is estimated that the small dowels should be expected to take only 60 per cent, and the large ones only 40 per cent of the above loads when the direction of application is at right angles to the grain. Tests have proved these dowels to possess the great advantage of making joints with green timber which, after seasoning, were equally as strong as those made of seasoned timber.

A special type of these dowels, known as the Korbsch doubly-coned dowels, is designed for use when gusset plates are inserted

between two pieces of a built-up member. Metal dowels are used with metal gusset plates, and hardwood dowels with plywood gusset plates.

The best practice in the assembly of structures with disk and coned dowels is to bore the bolt holes first and with a special drill designed for the purpose, then a recess for the dowels, using the bolt holes as a guide for proper centring of the dowels.

Modern connectors for timber joints possess many advantages. They produce stronger and more efficient joints. They are particularly suited for shop fabrication. Some types, such as the Bulldog plates, are useful for the employment of rough round timbers. Others, such as the S. B. U. claw plates and hinge joints can be used to make structures which are capable of being taken down and re-assembled without damage to the timber. In this way oil derricks, for example, can be dismantled and re-erected in a new location without loss. The use of the modern connectors actually encourages the employment of timber with preservative treatment, by affording opportunity for creosoting, etc., after all framing, cutting and boring are completed.

THE EFFECT OF THINNING OUT MULTIPLE SHOOTS ON YOUNG ROOT-STOCKS.

By H. G. Champion, M.A., Silviculturist, F.R.I.

It often happens that more than one shoot develops from young root-stocks owing either to some innate tendency to grow in this way, or to planting method, or to the results of injury to the originally single leader by insects, frost, fire or other agency. The question often arises, just as it does with coppice working, whether it is desirable or advantageous to thin out the shoots to one or two, *i.e.*, whether an increase, qualitative or quantitative, in growth will result in the retained shoots sufficient to make up for the loss of the increment which would have been obtained on the shoots which are removed.

In the past, a number of experiments on the point have been made in coppice coupes, but none of them have given conclusive results as the experimental technique has been too faulty on the counts of lack of demonstration of comparability of the thinned and unthinned plots, and of methods of assessing results.

This is one of a number of problems which are much better studied in the first place on individual trees or stools without the extra difficulties and complications introduced by the addition of the acreage factor. Most of the technical difficulties are overcome if the required number of suitable stools are chosen scattered over a plot or coupe and sorted into comparable sets of twos, threes, fours, etc., each set shewing only a limited range of size and height and having the same number of shoots. This sorting is done in the office and results in an acceptable randomising in the field. One member of each set is then taken as the control and the remainder are distributed to the several treatments. In the small experiments to be described, only one treatment was tried, *viz.*, reduction of multiple shoots to one, so the comparable sets each consisted of two stocks. A common error which by a misunderstanding crept into this investigation the first time it was taken up, is to accept for the single shoot, plants which have only produced one shoot, a step which alters the problem to a comparison of the growth of single and multiple shoots, a different matter altogether.

Large numbers of plants are not usually required, and on preliminary results it is simple to calculate the experimental error and thence the numbers required to give a required degree of precision (Cf. *Statistical Code*, p. 4). Ordinarily not less than 50 pairs may be recommended, but even 25 might give a satisfactory result under favourable circumstances. One initial and one final measurement are all that are required, so that such investigations are exceptionally easy and straightforward. It is often found that besides the main shoots between which considerable competition is to be expected there are other minor shoots ; these can be ignored or cut back at the same time with little danger of obscuring the issue, though of course one would apply the same procedure throughout.

As a sidelight on the problem, it may be mentioned that many arboriculturists avoid cutting back side shoots or branches more than is necessary to get ultimately shapely form in trees, on the grounds that their growth contributes to the general vigour of the plant, especially of the root system, which will ultimately benefit the leading stem ; only the terminal portions are removed to ensure the dominance of the favoured shoot. Again, in a comparative study of the development of different types of *sal* seedlings, it was found that a dominating shoot of a given height grew rather better if there were subsidiary smaller shoots on the stock, than if there were no such shoots.—(*Ind. For. Rec.*, Vol. XVI, Pt. V, p. 18.)

Experiments with *Bischofia javanica* and *Tectona grandis* made in 1929 and 1930 using plants raised from stumps have already been reported (*Ind. For. Rec.*, Vol. XVI, Pt. VI, p. 74) being summarised as follows :—

" A difference of five per cent was found (in height growth at the end of the first season after thinning) in favour of reducing the shoots to one, the difference approaching significance. (The position was identical after three seasons.)

Tectona grandis.—Two independent experiments shew a superiority in the single shoots amounting to 5—10 per cent at the end of the first season, the differences approaching significance. (As noted above, the initial treatment was open to criticism, so the experiments were concluded.)"

In 1933, three replications were made of the experiment with teak, avoiding the errors of the earlier work. One, (*iii*), utilised some well grown lines five years old, the other two, (*iv*) and (*v*), the four year old plants of another experiment with stumps. The stems were all coppiced in April. Early in May when the shoots were about 3 ft. high, they were sorted out into comparable pairs and the superfluous shoots were cut back on one of each pair, the other forming the control.

The results at the end of the growing season are as follows :—

Treatment.	Number of sets.	Initial height.	Final height.	Height increment.	Difference of height increment.
		Ins.	Ins.	Ins.	Ins.
(*iii*) Single ..	37	37·3±1·29	136·6±5·45	99·3±5·60	11·1±6·48
Multiple		37·2±1·29	147·6±2·99	110·4±3·26	
(*iv*) Single ..	35	30·5±1·03	121·7±3·98	91·2±4·11	8·1±4·45
Multiple		30·6±1·07	113·7±4·19	83·1±1·70	
(*v*) Single ..	64	27·8±0·93	108·1±2·84	80·3±2·99	1·5±4·25
Multiple		28·0±0·91	106·8±2·88	78·8±3·02	

From this it will be seen that in no case is any significant difference apparent, and what difference there is (about 10 per cent) is in opposite directions in replications (*iii*) and (*iv*).

Actually the standard errors of the final heights are rather high and to reduce them all to 2″ or less, the numbers of sets should have been about 280, 140, and 100 in the three replications.

The general conclusion is that in five experiments no advantage has been proved to result from the removal of extra shoots as far as maximum height growth is concerned, and the probability of the existence of any important advantage is small. The effect on stem form and diameter growth has not been studied as teak studies at Dehra Dun are all so fundamentally altered by the recurrence of winter frost.

ANDAMAN FORESTS AND THEIR REPRODUCTION.

By B. S. Chengapa, P.F.S.

Part I.—The Forest Types.

"I say, what have *you* done to be sent to the Andamans?" was the greeting of many of my friends in Coorg when they heard that I was to be posted here. "It is my past *karma*,—perhaps I murdered some one in my last life and escaped punishment" was my response in the usual Indian manner. The late Mr. Worsley,

Port Blair Harbour—Chatham Island—the Pivot of the Forest Department.

Photos B. S. Chengapa. Ross Island, the Seat of the Local Government.

I.C.S., then Chief Commissioner of these Islands, in an after-dinner speech shortly after his arrival in Port Blair said that his friends in Simla when they heard of his posting wanted to know what he was being sent down here for? There is no doubt but that from the Himalayas down to Cape Comorin and among both the higher and the lower order of society in India, the prevalent belief is that the Andamans is the home of the worst type of anophelene mosquitoes and sandflies, thieves and robbers, dacoits and murderers and all that is worst in God's creation.

It was to such a land that I was irresistibly driven by the Fates to seek my bread. I therefore felt as though I were being marched to the fatal steps of the guillotine in the days of the reign of terror in France when I boarded the good ship "Maharaja" with my wife to share my exile and landed in Port Blair four years ago.

In Port Blair, when I saw the delightful and picturesque country, a beautiful harbour with two or three ocean-going ships at anchor and at the jetty, busy emptying or filling their holds with cargo, a dozen or more steam tugs and launches ploughing their way to and fro through the still waters of this fine harbour; and when I saw the Aberdeen bazaar which any Indian town may justly be proud of, with its electric lighting and telephonic communication, when I saw some 200 or more motor cars and buses, busy plying up and down to the jetty, the bazaar and elsewhere, two huge government sawmills and the local match factory all with their tall smoking chimneys, and when I saw even a cinema hall, full to the brim with the vivacious and care free Burmans dressed in their multicoloured *aingis* and *lungis* I heaved a sigh of relief and felt myself transported to the veritable fairyland of Hans Anderson.

It is true that the majority of the population are murderers and dacoits, but they are all labelled with a number and not one of them can go about in the garb of a saint or a gentleman as they frequently do in India and elsewhere. In this way we soon learn how to deal with them.

Malaria does certainly exist, but the Local Government has recently spent large sums of money in trying to eradicate this scourge

and has succeeded to a considerable extent in doing so. If, however, the quality of the locality can be assessed by its indicating wood we have to quote one example, Mr. Bonington late of the forest service and one of the oldest residents—36 years in the Andamans and now 60 years of age—whose still persistently youthful appearance and unlimited energy will easily enable these Islands to be placed in Class I.

Area and Situation.—The Andaman Islands big and small are 204 in number with an area of 2,500 square miles. They are tucked away in the south-east of the Bay of Bengal between the latitudes of 15° 41′ and 10° 30′ north and the longitudes of 92° 11′ and 93° 7′ east. The smallest island is a few square yards in extent, just awash or submerged at high tide with half a dozen mangrove trees appearing to grow out of the depths of the sea. The biggest is the Middle Andaman with an extreme width of 19 miles and an extreme length of about 70 miles supporting a luxuriant growth of tropical evergreen and semi-evergreen vegetation rich in species and in value.

Configuration.—The configuration of these islands is very irregular with numerous ridges and knolls branching out in a confused manner from the main ranges of hills that generally run north and south. The higher range runs nearer the east coast rising up to 2,402 feet in Saddle Peak in North Andaman. There are no large rivers, and perennial streams are few. Level land is rare except along the coast or in the valley, usually only on either side of a stream.

Coast-line.—The coast line of the islands is greatly broken by deep indentations, some of which form excellent and well sheltered harbours. Tidal creeks, some of which are navigable for large steam launches, are numerous and run far inland dividing the islands into little narrow wooded belts which in places are only a few yards wide, thus creating a condition most ideal for the exploitation of the immense wealth that is locked up in these forests.

Climate.—The climate is warm and equable, the mean temperature in shade varying from 70° F. to 90° F. with a perceptible touch of cold during December and January when fogs and chilly nights

are common. In these months a heavy dew drips from the trees in the mornings as is the case in the Nilambur teak forests in the cold weather. February and March are often sultry with very little wind. South-west and north-east monsoons blow with regularity from May to October and from November to January. The average rainfall is about 150 inches a year, but varies to an extraordinary degree in places quite close to each other. Precipitation generally occurs every month, though the bulk of it falls from June to October. Cyclones rarely occur, though stormy weather conditions prevail at the beginning of the south-west monsoon in May-July, and also at the change of monsoons from the middle of October to the end of November.

Geology.—The islands are a southward extension of the Arakan Yoma range. The underlying rocks over the greater part of the islands are chiefly non-micaceous hard coarse-grained sandstone, indurated clays and slates, conglomerates, pale grey limestones and indurated and altered intrusions of serpentine. Coral formation is found along the coasts. Soft limestone chiefly of shell sand, soft calcareous sandstones, and white clays with occasional conglomerates are the chief rocks of the archipelago. The white clayey limestone cliffs almost surround Havelock Island and can be seen from a distance of some 25 to 30 miles.

Soil Formation.—The following types of soil formation are easily distinguished and are of considerable importance to the forester, as the distribution of different types of vegetation depends almost entirely on the presence or absence of a particular soil. This is especially so in the South and Middle Andamans. The main types of soil are :—

1. *Marsh alluvium.*—Fairly deep and formed by the clayey or sandy loam deposits brought down by rain water from the adjoining rising ground. This is found in all bays and creeks and along the coast line usually sheltered from the intensity of the monsoon winds. It is fairly extensive, forming about 18 per cent of the total area and is inundated at regular intervals by the rise and fall of the tides. This is entirely occupied by mangroves.

2. *Sandy beach.*—Raised by the action of wind and waves just above the reach of high tide, it consists chiefly of sand and shingles, mostly calcareous, lumps of old coral and broken shells. It is extremely porous and the streams coming down from the hills disappear here to emerge again at the sea line or in the sea. This type of formation is confined to the sea coast and is limited to narrow belts and strips. *Sea mohwa* (*Mimusops littoralis*) is the predominating species in this soil.

3. *Drained alluvium.*—Consists chiefly of deep fertile clayey loam or sandy loam formed in the same way as the marsh alluvium. It is out of reach of sea water and is found along the creeks above the marsh alluvium, or along the coast between the sandy beach and the hilly ground, along stream margins and in valleys and depressions. The extent of this formation is about five per cent of the total area. *Dipterocarpus alatus*, the most magnificent of all the Andaman trees, grows mostly on this soil.

4. *Low undulating ground with local padauk soil.*—This is formed by the disintegration of indurated clays and shales, limestones and conglomerates, the matrix of which is mostly clayey and hard coarse grained non-micaceous sandstones. The soil varies from clayey loam to a coarse rubbly sandy loam and is very shallow in some places. There is no trace of visible humus. It is rich, but dry and waterless in the dry season, and gives rise to deciduous and semi-deciduous forests of great economic importance. The chief species is *padauk* (*Pterocarpus dalbergioides*). Its distribution is confined to the lower slopes and the undulating ground between the alluvium and the hills and is by far the largest in area, about 45 per cent. It is rarely found beyond an elevation of 300 or 350 feet.

5. *Hills.*—The hills consist of stiff clayey soil or dark red loam overlying a micaceous sandstone formation and an intrusive serpentine. It is moist throughout the year and there is no scarcity of perennial springs, though the flow of water in the dry weather is small, chiefly due to the catchment areas being small. Typical tropical evergreen forests are found here, and the chief species of

economic importance, *Dipterocarpus grandiflorus*, grows here at its optimum.

Types of Vegetation.—Except for 70 square miles cleared for the Settlement the whole area from the water's edge to the summit of the highest peak is beset with a luxuriant growth of dense forest characteristic of a region of warm climate, heavy rainfall and high atmospheric humidity. Even armed with a *dah*—(Burmese cutting knife)—one finds it extremely difficult to clear a track. As a rule from the ground level up to 150 feet or more it is one mass of green vegetation tangled together by enormous climbers, thorny canes and the impenetrable climbing bamboo that carpets the lowest ground and festoons the highest trees. Scrub jungle on high hills and on very steep slopes is the only exception to this rule. Sir A. Rodger, late Inspector General of Forests, in his 'Tour of inspection in the Andaman Islands, 1927,' says that he has never seen a denser forest in any part of India or Burma.

The formation of different types of vegetation is purely edaphic and follows closely the classification of soils. Aspect, that can hardly be ignored in any other part of the world, has very little influence on modification of types in these islands. Except on closer examination and in dry months, the general character of the growth appears to be uniform throughout. Deciduous and evergreen forests grow on similar elevations, on similar aspects and in regions of similar rainfall, the sole deciding factor being the soil and the subsoil.

The main types of forest in the Andamans are :—1. mangrove forests, 2. beach forests, 3. low evergreen forests, 4. hill evergreen forests and 5. deciduous and semi-deciduous forests. These types, although visibly distinct, merge into one another almost imperceptibly and take on the attributes to a large extent of neighbouring types into which a species has straggled. I have seen *padauk* (a distinctly deciduous tree) with its leaves still green in the low evergreen and the hill evergreen areas when the same species was absolutely leafless in deciduous areas. Mangrove is alone in its exclusiveness.

Mangrove Forest.—Mangrove forest occupies the marsh alluvium and is found lined up on either side of nearly all the creeks, on low islands and other coast lines sheltered from the force of the wind and waves. It extends as far as the high tide can reach, fringing the coast lines and occupying the lowest elevation. Of quite equal height growth and in some cases the crowns clipped like a flat topped hedge by parakeets, these forests with their heavy and vividly green foliage, are a very pleasing relief to the dreary expanse of the sea and form a beautiful setting for other types of vegetation on higher elevations.

Of the component species the most gregarious and predominating. *Rhizophora mucronata* and *R. conjugata*, are found almost exclusively on the outer limits facing the sea. Closely set and forming a very strong and effective sea wall with masses of stilt-like roots, they make penetration impossible. Immediately behind this or more correctly where the influence of fresh water is felt, are found two other species, *Bruguiera gymnorhiza* and *B. parviflora*. The former is the largest species of mangrove and next in abundance and gregariousness only to the *Rhizophoras* and gives the appearance of a well tended plantation with a clear bole 60-80 ft. high and a girth of 5-6 ft. and with a clean ground floor except for the numerous knee roots which make walking extremely difficult. These four species form very good fuel and are considered next best to coal by the crews of the steam launches. *Avicennia officinalis* with plentiful pneumatophores also forms occasional gregarious groups. Other species of true mangroves are about 15 in number but not so common. *Ceriops candolleana*, *Kandelia rheedii*, *Carapa obovata*, *C. moluccensis*, *Sonneratia acida*, *S. alba* and others are found dotted about everywhere. *Heritiera littoralis*, *Phoenix paludosa*, *Nipa fruticans*, *Licuala spinosa*, *Barringtonia racemosa*, *B. speciosa* and *Brownlowia lanceolata* form the outward fringe of the swamps that are reached only by the spring tide and gradually give rise to other types of vegetation. It is estimated that about 160 tons of timber per acre are available (Inspector-General of Forests' Note 1928) and the area occupied is roughly 450 square miles.

Beach Forest.—These are found lined along the coast in narrow belts from a few yards to a furlong or more in width, just above the high tide and exposed to the full force of the monsoon winds. They grow on sandy beach formed by sand and shingles banked up by wind and waves, and on the detritus brought down by streams. These forests act as very efficient shore protectors and wind belts especially on the west coast where the contorted appearance of the crown of *Mimusops littoralis*, the most predominating species of this formation, tells its own tale. On the loose knit sand often reached by high tide *Ipomoea biloba*, *Crinum asiaticum*, *Vigna retusa*, *Pandanus tectorius*, *Scaevola koenigii* and a few others form the only growth. Behind these and on firmer soil sometimes reached by high tide we have *Hibiscus tiliaceus*, *Morinda citrifolia*, *Thespesia populnea*, *Pongamia glabra*, *Desmodium umbellatum*, *Gyrocarpus americanus*, *Erythrina indica*, *Barringtonia speciosa*, *Calophyllum inophyllum*, *Terminalia catappa*, *Cordia subcordata*, most of these leaning out towards the sea and sometimes heavily laden with straggling shrubs and climbers such as *Colubrina asiatica*, *Caesalpinia bonducella*, *Mucuna gigantea* and various *Ipomaeas*. *Mimusops littoralis*, the towering giant of the littoral forest, sometimes grows pure on flat and deep sand deposits and provides a hard and durable timber. The total area of this type is negligible and is about one or two per cent of the total area.

Low Evergreen Forest.—Leaving the mangrove and beach formations, unless the ground rises abruptly we come to the low evergreen forests,—the densest in the Andamans. This type is confined mostly to the drained alluvium which forms the banks of larger streams, moist valleys and depressions and the inner extensions of tidal flats. It gives rise to a magnificent growth of species found both in deciduous and in evergreen areas, very often with huge buttresses. One such buttress of *padauk* yielded a one-piece oval table 12′ 9″ by 7′ for the late Lord Kitchener.

Dipterocarpus alatus, the biggest tree of the Andamans, with its usual associates *D. pilosus*, *Sterculia alata*, *S. campanulata*,

Terminalia bialata, T. procera, Albizzia stipulata, A. lebbek, Calophyllum spectabile, Bombax insigne, Artocarpus lakoocha, A. chaplasha and *Pterocarpus dalbergioides* form the predominating species and occupy the topmost storey 100 feet and over. Below this forming the 2nd storey between 50-100 feet are found *Lagerstroemia hypoleuca, Dillenia pentagyna, Dracontomelum mangiferum, Pometia pinnata, Myristica irya,* and *Pisonea excelsa* with wood so soft as to form an excellent elephant fodder. There are also *Litsaea panamonja, Xanthophyllum andamanicum* and many others less important. Forming the lowest storey are found *Fagraea morindaefolia, Talauma andamanica, Garcinia andamanica, Macaranga tanarius,* and *Aporosa villosula.* The ground is usually covered with *Saprosma ternatum, Maesa andamanica, Micromelum pubescens, Clerodendron infortunatum, Leea sambucina* and *L. acuminata, Clinogyne grandis, Licuala peltata, Caryota mitis, Areca triandra,* and *Saccharum* in open places.

Of the climbers and straggling shrubs and canes, *Dinochloa andamanica,* a climbing bamboo, *Thunbergia laurifolia, Ipomoea* sp., *Buettneria andamanensis, Combretum extensum* and *C. chinense, Daemonorops kurzianus, D. manii* and *Calamus palustris* form a rampant growth trailing over the ground and climbing into the highest trees. Only the top storey trees and a few in the second storey are really deciduous and that only for a short time.

Hill Evergreen Forest.—This is confined to the hills and ridges and to the eminences that emerge abruptly from the deciduous forests usually the outcrops of serpentine and sandstone formations. It is on these outcrops and on the lower slopes of the higher hills that we have the true and the most luxuriant growth of evergreen forests, the grandest of all the Andaman forest types. Every tree is clear boled and reaches enormous heights requiring field glasses to ascertain the form of the leaves. But, as we ascend higher to the ridges the height growth falls off and the trees become stunted and more numerous, dense and inextricably tangled with masses of climbers. The principal species, *Dipterocarpus grandiflorus* and *D. pilosus,* together with their associates *Artocarpus chaplasha* and *gomeziana, Calophyllum*

spectabile, *Planchonia andamanica*, *Hopea odorata*, *Endospermum malaccense*, *Sideroxylon longipetiolatum* and occasional *padauk* and *white dhup* (*Canarium euphyllum*) form the upper storey on the out-crops and on the lower slopes. *Dipterocarpus costatus*, *Mesua ferrea*, *Cratoxylon formosum*, and *Canarium manii* form the upper storey on hills and ridges and on higher slopes. *Xanthochymus andamanicum*, *Myristica andamanica* and *glauca*, *Baccaurea sapida*, *Croton argyratus*, *Pterospermum aceroides*, *Caryota mitis*, *Cryptocarya*, *Memecylon*, *Euphorbia* and small bamboos form the second storey. Small trees are few, *Mitrephora prainii* and *Actephila excelsa* being the chief.

The chief climbers are *Dinochloa andamanica*, *Calamus palustris*, *Gnetum scandens*, *Ancistrocladus extensus* and a few others that connect the crowns above and lie in snake-like coils on the ground below.

Deciduous and Semi-deciduous Forests.—Rising from the mangrove, the beach or the low evergreen forests and covering all the undulations and extending 300 feet or more up the hills and ridges as far as the soil conditions permit, these forests form the most important reserves of timber wealth of these islands. It covers as much as 45 or 46 per cent of the total area. *Padauk*, the most important and predominating timber species of these islands, with its equally important associates, *Terminalia bialata*, *Terminalia manii* and *Terminalia procera*, *Canarium euphyllum*, *Sterculia campanulata*, both much in demand as match wood, *Bombax insigne*, *Lagerstroemia hypoleuca*, *Tetrameles nudiflora*, *Chukrasia tabularis* and in moist localities *Artocarpus chaplasha*, *Dipterocarpus alatus*, *Parishia insignis*, *Bassia butyracea*, and *Albizzia lebbek* form the topmost storey above 125 feet in height. These trees with their huge buttresses especially in the case of *Tetrameles nudiflora*, *padauk* and *Terminalia bialata* are placed far apart and their widespread crowns rarely touch one another. Below these giants and forming the second storey above 50 feet and making a complete canopy are *Lannea grandis*, *Adenanthera pavonina*, *Sterculia villosa*, *Dillenia pentagyna*, *Diospyros marmorata*, the beautiful Zebra wood *Diospyros pilosula*, *D. pyrrhocarpa*, *Milius tectona*, *Sageraea elliptica*, *Cratoxylon formosum*, *Semecarpus kurzii*,

Zanthoxylum budrunga, *Celtis wightii* and *Cinnamomum zeylanicum*, *C. obtusifolium*, and *Pterospermum aceroides*. Below these forming the third storey are found *Murraya exotica* (which by the way makes fine walking sticks) *Atalantia monophylla*, *Limonia alata*, *Cohnawallichii*, *Canthium gracilipes*, *Ixora grandiflora*, *Grewia laevigata* and the small bamboos *Oxytenanthera nigrociliata* and *Bambusa schizostachyoides*.

Of the shrubs covering the ground the most common are *Alsodeia bengalensis*, *Mallotus accuminatus*, *Actephila excelsa*, *Randia longiflora*, *Harrisonia brownii* *H. bennetii*, *Glycosmis pentaphylla* and *Licuala peltata*.

The most common climbers and straggling shrubs that connect these different tiers in the canopy are *Ventilago madraspatana*, *Delima sarmentosa*, *Buettneria andamanensis*, *Acacia pennata*, *Entada scandens*, *Plecospermum andamanicum* and *Sphenodesme unguiculata*. There are also a variety of canes.

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(*To be continued*.)

CONTROL MEASURES FOR TERMITES.

By C. F. C. Beeson, M.A., D.Sc., F.R.E.S., Forest Entomologist, F.R.I.

Note.—This article summarises general experience in various parts of the world regarding possible preventive and remedial measures against termites, or white ants, with particular reference to the problems of forest departments concerned with the protection of forest buildings, stored timbers, living trees and nurseries. A limited number of reprints has been made which may be obtained price -/12/- per copy, post free, from the Honorary Editor, ***Indian Forester***, or the Forest Entomologist, Forest Research Institute, Dehra Dun.

I.—Protection of Buildings.

Termites which invade buildings and damage the woodwork therein are of several species, but they may be assigned to two distinct groups depending on the normal position in which the nest is constructed, either (*a*) below ground in the soil, or (*b*) above ground in masonry or woodwork. Species which nest below ground ordinarily enter buildings as workers and soldiers through the foundations and walls from the soil. The non-subterranean species, on the other hand, ordinarily arrive as winged sexual forms, and start new colonies direct from the egg in suitable crevices or cavities in the walls or timbers.

I*a*.—Preventive Measures.

CLEANING UP THE BUILDING SITE.—The sites for rest-houses, quarters for the divisional forest staff, sheds, depots, etc., which are selected in recently cleared forest or waste land should be cleaned of all breeding places. Not only in the foundations of the building, but also in the compound and immediate neighbourhood termite nests should be destroyed, and decaying logs, stumps and buried roots removed as thoroughly as the importance of the building demands.

Destruction of Mounds and Nests.—In order to destroy the nests of mound-builders, it is not sufficient to break up structures above ground and kill the queens ; each colony should be killed off with poisons or fumigants. Paris green is used as a dry powder mixed with dust or sand and dusted into the cavities of the nests. Sodium or potassium cyanide should be poured in as a 3 per cent solution in water. For fumigants the following may be used :—a mixture of 1 part creosote to 3 parts kerosine or petrol ; carbon bisulphide or carbon bisulphide emulsion ; dichlorobenzene (liquid or crystal). These liquids are poured in small doses and the excavation covered over with soil.

Petrol alone is effective if used in the following manner :— The diameter of the base of the mound should be ascertained and the

mound should then be levelled. Holes should be drilled in the levelled area at the rate of one hole for every six inches of diameter measurement and one ounce of petrol should be injected in each hole ; *e.g.*, a mound 18 inches in diameter requires 3 holes, and a mound 6 feet in diameter requires 12 holes and 12 ounces of petrol. The holes should be uniformly distributed and about 12 inches deep. The easiest method of injection is with a crowbar and a long necked funnel. Where funds permit, the Vermorel " Excelsior " Injector can be used with advantage as the dosage can be automatically regulated.—(Hutson).

Calcium cyanide is used in powder or granular form and can be applied with a large spoon or with a Cyanogas dusting-pump. A specially designed fumigating-pump, known as the Four Oaks White Ant Exterminator, exists for forcing the fumes of heated sulphur and arsenic into the nests of termites, but its use is not economical except where extensive building operations are contemplated in a bad white ant locality.

Where subterranean nests are abundant and diffuse, it is better to plough the soil deeply and treat it simultaneously with a disinfectant. Fresh nests may be formed in the soil by newly arriving winged forms and these should receive early attention.

USE OF RESISTANT TIMBER.—Timber may be naturally resistant to termite attack, or may be made so by treatment with suitable antiseptics. The resistance of a particular kind of timber to white ants may be known from its general reputation or from the results of experimental tests *ad hoc*, but neither criterion is infallible. The usual method of testing a timber is to bury a piece in the ground and leave it for several years. By this means it is subjected to the attack of only those soil-burrowing termites that happen to be established locally, and there is very little chance of ascertaining its reaction to the characteristic non-subterranean or house termites. Tests of this kind have been carried out at Dehra Dun and Pusa, as also in Ceylon and the F. M. S., which show that a durable timber varies very much in its resistance to the attack of different species of termites in different localities.

1. *Experiments at DEHRA DUN.*—The termites most abundant in this locality are *Odontotermes bangalorensis* and *O. obesus.*

(*a*) The heartwood of the following species is of very promising durability and may remain in the ground for *four* years without being attacked; these timbers are apparently resistant :—

Dalbergia latifolia.
Dalbergia sissoo.
Hardwickia binata.
Mesua ferrea.
Pterocarpus dalbergioides.
Shorea robusta.
Terminalia arjuna.

(*b*) The heartwood of the following species is durable but liable to slight attack by termites in 4-5 years :—

Lagerstroemia microcarpa.
Ougienia dalbergioides.
Parashorea stellata.
Terminalia tomentosa.

(*c*) The heartwood of the following species is of promising durability and may remain in the ground for 3-4 years without being attacked :—

Artocarpus hirsuta.
Castanopsis tribuloides.
Cleistanthus collinus.
Dalbergia oliveri.
Dysoxylum binectariferum.
Dysoxylum malabaricum.
Eriolaena candollei.
Gluta tavoyana.
Gluta travancorica.
Heterophragma adenophyllum.
Homalium tomentosum.
Hopea parviflora.
Lagerstroemia hypoleuca.
Melanorrhoea usitata.
Pentacme suavis.
Shorea obtusa.
Soymida febrifuga.

(*d*) The heartwood of the following species is durable but liable to slight attack by termites in 3-4 years :—

Albizzia lebbek.
Albizzia procera.
Artocarpus chaplasha.
Calophyllum tomentosum.
Dipterocarpus indicus.
Eugenia gardneri.
Hopea odorata.
Pentace burmanica.

Calophyllum wightianum
Cedrela serrata
Cedrus deodara.
Dalbergia paniculata
Dichopsis elliptica.
Dipterocarpus alatus.
Phoebe hainesiana.
Poeciloneuron indicum.
Pterocarpus marsupium.
Tectona grandis.

2. *Experiments at PUSA.*—Experiments carried out on the durability of timbers treated with various proprietary antiseptics showed that wood has a considerably shorter life in the soil of Pusa, Bihar, than at Dehra Dun, possibly due to the fact that the local termite is *Microtermes obesi.*

3. *Experiments in CEYLON.*—The commonest soil-burrowing termites in Ceylon are *Odontotermes horni, O.* (*Hypotermes*) *obscuriceps, O.* (*Cyclotermes*) *redemanni* and *Coptotermes ceylonicus.*

Immune Species.

Artocarpus integrifolia.
Azadaracta indica.
Bassia latifolia.
Borassus flabellifer.
Chloroxylon swietenia.
Diospyrus ebenum.
Hopea odorata.
Mesua ferrea.
Mimusops hexandra.
Pericopsis mooniana.
Tectona grandis.
Thespesia populnea.
Vitex altissima.
Xylia dolabriformis.

Resistant Species.

Alseodaphne semecarpifolia.
Artocarpus nobilis.
Berrya ammonilla.
Calophyllum sp.
Chikrassia tabularis.
Dillenia retusa.
Doona zeylanica.
Eugenia sylvestris.
Tamarindus indica.

4. *Experiments in MALAYA* (*F. M. S.*)—The termites present in the experimental area near Kuala Lumpur, F. M. S. are *Macrotermes gilvus* and *Rhinotermes* (*Schedorhinotermes*) *malaccensis.*

1. The heartwood of the following indigenous species is very durable and may remain in the ground for five years without being

attacked; these timbers are highly resistant but not wholly immune during the course of ten years.

Balanocarpus heimi.	*Madhuca utilis.*
Cassia siamea.	*Shorea ciliata.*
Hopea nutans.	*Shorea utilis.*

2. Of the Indian and Burmese timbers tested in this locality (*a*) the following proved very durable, remaining unattacked during five years:—

Pentacme suavis.	*Xylia dolabriformis.*
Terminalia tomentosa.	

(*b*) and the following proved durable:—

Heritiera minor.	*Mesua ferrea.*
Hopea odorata.	*Tectona grandis.*

(3) and the following not very durable:—

Calophyllum inophyllum.	*Rhizophora conjugata.*
Heritiera littoralis.	*Shorea obtusa*
Lagerstroemia flos-reginae.	*Shorea robusta.*

USE OF TREATED TIMBER.—The most satisfactory method of rendering timbers white-ant-proof is impregnation with coal tar creosote, either by the full cell process under pressure or by the open tank process. The latter is the simpler process for operation with unskilled labour and will render timber immune for 10-15 years; the former is applicable when permanent immunity is essential. Full details regarding both processes can be obtained from the section of Wood Preservation at the Forest Research Institute, Dehra Dun. For temporary protection, three coats of hot coal-tar creosote can be brushed on the surface of the wood, each coat being allowed to dry before the application of the next. All treated timber after sawing should have the cut surfaces re-creosoted. Tarring is useless. For interior woodwork, which cannot be oiled, water-soluble or colourless antiseptics such as zinc chloride, copper sulphate and sodium fluoride can be used in conjunction with white arsenic. These three salts are fungicides and alone are not very poisonous to termites. Details

as to strengths, quantities, etc., of antiseptics are available at the Forest Research Institute, Dehra Dun.

CONSTRUCTION OF TERMITE-PROOF BUILDINGS.—The precautions that can be taken in order to construct a termite-proof building depend on the type of building to be erected.

There are types of buildings which are impossible to protect, *viz* :—

Buildings with earth or cowdung floors or mud walls.
Walls of sun-dried brick or burnt brick in mud-mortar.
Walls of stone or laterite in mud-mortar.
Walls of brick or stone in lime-mortar with earth filling.
Wattle and daub or bamboo matting and daub.

Of the buildings that can be made termite-proof, there are two main types (*a*) those having concrete floors in contact with the ground, and (*b*) those having floors raised above ground by masonry pillars or wooden posts.

One important factor in protection lies in the insulation of timber from contact with earth. "Complete insulation from the ground of all untreated woodwork of buildings is the only effective permanent remedy against attack by subterranean termites, and the only relief from their presence. These insects must maintain contact with the ground to obtain the moisture necessary for their existence. When contact with their moisture supply in the earth is cut off, the subterranean insects in the damaged wood, no matter how numerous, soon dry up and die." (Snyder). There should be a layer of dense concrete at least an inch thick between any timber, such as door-sills, flooring joists andplanks, posts, steps, etc., and the rougher concrete foundation.

Beams should not be completely surrounded with mortar or brick, but should have an empty space round them sufficient for the circulation of air, that is, boxed not sealed.

CONCRETE FLOORS—The ideal concrete floor desirable from the standpoint of the termite hazard is one laid down on a solid, not filled-in, foundation in a continuous course unbroken by settlement

joints and firmly united to the foundation walls with a concave " sanitary " cement skirting.

The ordinary forest building, however, has a raised plinth with a floor constructed above filled-in earth often on an uneven site, and the filling is not always uniformly consolidated. In the subsequent settlement the concrete cracks, either at the junction with the foundation wall, or within the floor space, wherever the greater weakness occurs. Where such a readjustment is anticipated, a sectional floor with settlement joints can be provided, and the floor laid in independent sections ; these joints are usually filled with cement or mortar or asphalt. In practice settlement joints or expansion joints also crack, as may also the cement surface rendered over the concrete. Termites are able to work through these cracks and through rough porous concrete. The only satisfactory remedy for settlement is frequent repointing or grouting with cement or hot asphalt as new cracks are formed. Constructional designs that would prevent this trouble involve the use either of reinforced concrete, or of metal bonding strips let in across the settlement joints, or more complicated specifications beyond the possibilities of forest departmental buildings.

WALLS.—To be termite-proof foundation walls should be made entirely of stone or brick in lime-mortar or cement-mortar, or of solid concrete and, if properly constructed, are actually impermeable to termites. In practice there are points of weakness especially in the mortar joints on the side faces, through which the insects can gain an entrance. Inferior lime-mortar disintegrates in the course of time and allows termites to enter between bricks: the parts of such walls which are in contact with earth should be faced or pointed with cement.

Termite Barrier.—The ascent of termites from below ground into the upper parts of the walls can be prevented by interposing a termite-barrier. This can take two forms :—(*a*) A continuous concrete course, three or four inches thick and projecting three inches outwards from the wall on each side, placed between the foundation and the superstructure at the level of the top of the floor. Such a barrier serves also as a damp-proof course if water-proofing materials are incorporated in the concrete or spread on its upper surface. So

long as the barrier is not broken after construction in order to add bath-room waste-pipes, door-sills or to bond additional walls, etc., it functions effectively and permanently (See Fig. 1, Plate 7.)

(*b*) An alternative termite-barrier particularly for external walls to check the progress of termites working on the face of the wall under runways or sheets of mud, is in the form of a "strip of non-corroding metal (such as copper, or zinc, or an alloy composed of 28 per cent of copper, 67 per cent of nickel, and five per cent of iron, manganese, and silicon), firmly inserted in the surface of the masonry or between the foundation and the wood, with the projecting edge bent downward at an angle of 45° and extending horizontally at least two inches from the face of the foundation. In masonry buildings this shield can be inserted in the masonry at a height at least 18 inches above the ground." (Snyder's specification) (See Fig. 2, Plate 7.)

A termite-barrier is of little use unless complete around the whole plinth and the internal walls. The principle of complete insulation of the superstructure from the foundations and the ground is one that should be understood by the contractor and workmen, and should be borne in mind when breaches are made in the barrier at later stages in construction or in subsequent work on the building after its erection.

RAISED FLOORS.—Buildings with the floors raised above ground level are roughly of two classes, (*a*) timber buildings constructed wholly of timber, or (*b*) frame buildings supported on pillars of brick or masonry.

Timber buildings supported on vertical posts have the posts sunk deep in the earth, or, more rarely based on masonry foundations. For this purpose only creosoted posts should be used. In the case of buildings constructed in the forest where no tank is available, butt treatment normally gives sufficient protection. But if the local termites are species that work over the oiled surfaces in tunnels of earth and excrement, it is necessary to interpose on each of the posts, between ground and floor a termite-barrier in the form of a metal collar, *i.e.*, a strip of non-corroding metal or galvanised iron turned

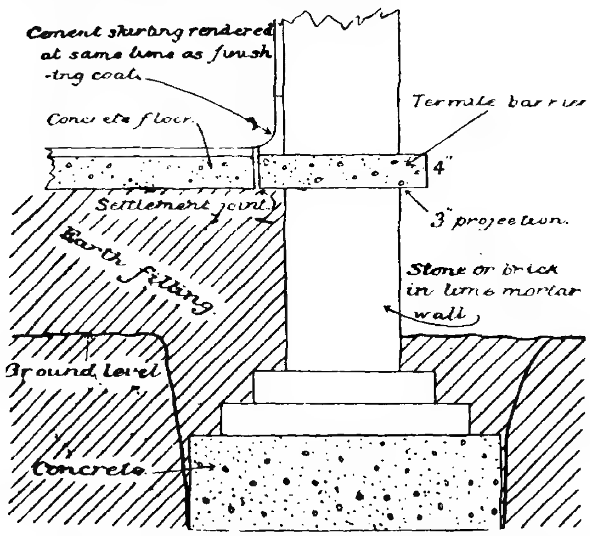

Fig. 1. Foundation wall showing position of a concrete termite-barrier with reference to a concrete floor above earth filling and cement surfacing (adapted from Jepson and Woodeson).

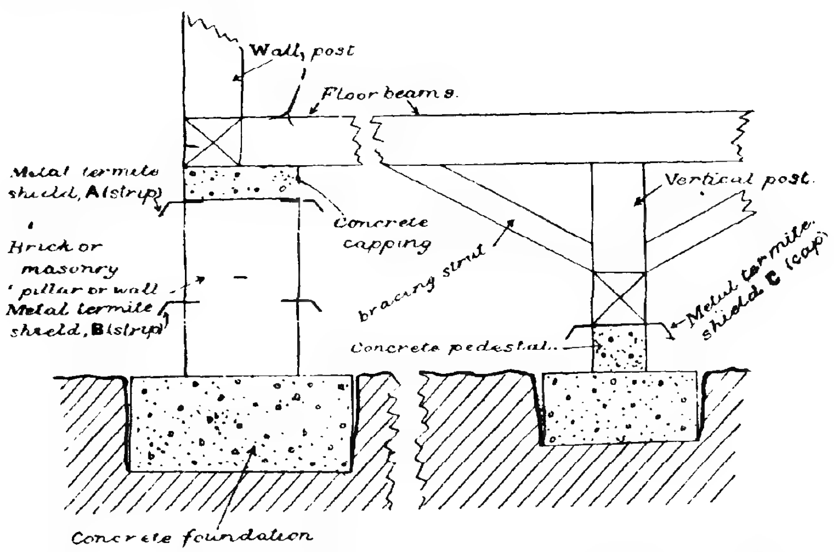

Fig. 2. Foundation walls and pillars of a wooden frame-building showing the position of metal termite-shields. A, on a stone wall, B, alternative position on a brick wall or pillar, C, on a concrete pedestal.

Beeson : Control Measures for Termites.

over with a projection of two inches and bent down at an angle. Posts ending short at floor-level can be entirely capped with a shield shaped like an inverted square tray or pan; side posts that continue past the floor and support the roof must be fitted with a collar. As circular collars are difficult to fit, this necessitates the use of squared posts or the fashioning of a squared or hexagonal head to a rough hewn post. The metal strips should be soldered where the angles meet, and embedded in asphalt where nailed to wood.

Frame buildings with the floor-frame supported on pillars of masonry or brickwork may be protected by capping each of the supporting pillars or the skirting wall with a concrete termite-barrier, as illustrated in Fig. 2, Plate 7. Metal shields may be used instead or in addition (See Fig. 2, A); the complete cap is suitable for pillars of small bearing surface (Fig. 2, C); the continuous strip is suitable for lengths of walling and may be inserted at the top of a stone wall (Fig. 2, A) or in one of the courses in a brick wall (Fig. 2, B).

I*b*.—REMEDIAL MEASURES.

Evidence of attack—The infestation of buildings by termites may be recognised by the presence of (*a*) earth-covered runways in the cracks and joints and over the impenetrable surface of floors and walls, (*b*) earthen tubes projecting from various positions, (*c*) the shed wings of flying termites that have emerged within rooms, (*d*) the dry powdery pellets of excrement thrown out of cracks, and (*e*) the unmistakeable evidence of hollowed out woodwork and soldiers and workers *in situ*.

If specimens of termites can be obtained and preserved, they should be sent to an expert for identification in order to determine if the infestation had its origin from the soil (subterranean species) or from winged adults flying in from outside (non-subterranean species).

Temporary Remedies.—The cracks and holes indicated by tracing back the runways and tunnels of termites at work should be opened up as much as possible and washed out with insecticides such as petrol, kerosine oil, dichlorobenzene, creosote, etc., singly or mixed or emulsified. Paris green dust blown into holes or tunnels is effective for a

longer period. Cavities formed in concrete or in walling should be filled up with cement. Damaged woodwork should be replaced with antiseptically treated pieces. If damage occurs in damp places due to the leakage or splashing of water, the drainage should be improved, leaks repaired, and ventilation provided. Termites in furniture, boxes, etc., can be killed by putting the articles out in the sun for some hours; ants help in cleaning things up.

So long as the chance of re-infestation of the superstructure exists by (*a*) the arrival of fresh lots of worker termites from underground, or (*b*) the formation of new colonies by fresh swarms of winged adults, the remedy is only temporary.

Permanent Remedies.—Permanent protection in termite damaged buildings is obtainable by applying the same principles as have been outlined under Preventive Measures.

1. Against subterranean termites. If infested woodwork is completely disconnected from the ground the termites in it will die out. Infested timbers need not be removed or replaced unless seriously weakened structurally.

Timber in contact with the ground must be removed and replaced by a layer of concrete properly isolating the earth from the timber above. Walling in which inferior mortar has been used, or which has a core of earth or rubble, should be faced on all sides with Portland cement. Metal termite-shields fitted to such walls would be ineffective unless accompanied by cement plastering and capping to complete the barrier.

2. Against non-subterranean termites. Where the danger of infestation by flying termites is persistent, all exposed woodwork should be periodically treated with antiseptics. Doors and windows should be provided with wire-gauze screens, which should be kept closed during the swarming season of the local termites.

II.—Protection of Stored or Converted Timber.

Stored Timber should be stacked on supports of concrete, brick or stone, or a creosoted wooden frame work, and periodically inspected for termite runways. Where the danger is great, the foundation

pillars or piles should be capped with termite shields. In properly built stacks with adequate air-circulation, there is little danger of nests being established by flying termites.

Converted timber used in the ground, *e.g.*, fence-posts, railway-sleepers, bridges, etc., can only be protected by treatment with creosote and similar oils or with soluble antiseptics containing arsenic.

III.—Protection of Living Trees.

(*a*). *Preventive Measures.*

Seed-beds, Nurseries.—When making a nursery for trees in cleared forest land, the site should be cleaned of all woody surface débris, logs, stumps, etc., and the ground worked over for the discovery of termite nests as recommended for sites for buildings (See page 65). The nursery can further be partially isolated by digging a deep trench round its perimeter. Wooden boards used for the edges of seed-beds, wooden posts for supporting shade-matting or thatch should be creosoted to avoid the concentration of termites near the plants. Litter, humus, or manure brought in from outside should be inspected for the presence of termites, and if infested, should be sterilised by spreading in the sun or raking over and compacting.

Transplants.—Much of the subsequent injury to transplants is due to injury to the roots at the time of lifting and by drying up before replanting or by bad root and top pruning. Injured roots die back during the dry season and also during periods of water-logging. Termites attacking the dead roots continue to work on the living tissues when the resistance of the plant is lowered. Careful transplanting is the cure. Under special circumstances a soil fumigant might be used, but the measure should not be tried without expert advice.

Patch sowings.—Seeds dibbled in in small numbers or broad-cast on small patches are liable to attack if the soil contains an abundance of leaf and woody litter. Hence sowings on ash-beds are more satisfactory. Stakes that are used to mark patches of sown seeds should be dipped in creosote.

(*b*). *Remedial Measures.*

Nurseries, etc.—When young plants are observed to be dying off in seed-beds and in nurseries, the lines should be systematically examined and the upper layers of soil turned back and watered with crude oil emulsion or dusted with centrifuged napthalene, Paris green, or calcium cyanide, or sprinkled with dichlorobenzene (liquid or crystals) and the soil replaced; the dry powders should be mixed with sand or ashes for even distribution. The most suitable insecticide to use and the strength at which it is effective, depend largely on the age and species of the plant (some trees are susceptible to soil insecticides) and on the kind of soil and the season of year. Experience is insufficient to do more than advise these remedies for local experiment. Under certain conditions good results have been obtained by burying saw-dust poisoned with Paris green (100 parts sawdust to one part Paris green), or saturated with a 10 per cent solution of sodium arsenite near the affected area as a bait. Pieces of softwood planking similarly poisoned can also be used.

In the absence of a properly tested insecticidal measure, it is effecttive to dig over the soil of the beds repeatedly at short intervals, which will disturb the termites and drive them elsewhere, *e.g.*, into trenches or waste ground which has been covered with dry cut grass; when the grass is full of termites, it is fired.

Saplings and older trees.—For termite attack in plantations of the sapling and older stages, no practical remedy is available. In the case of an exceptionally valuable crop on a par with tea, rubber and coconut, or in the case of isolated trees, roadside and garden avenues, etc., protective measures are possible. Against termites that work on the bark externally under cover of a sheet of mud, a wash made of two parts quicklime slaked in as little water as possible to one part lead arsenate or Paris green should be painted on in a foot wide band.

Against species like *Kalotermes*, which excavate tunnels and nest-cavities in the heartwood of living trees, Paris green is an effective poison. A hole is drilled in the cavity with a gimlet or brace and bit and the

powder is blown into the hole by means of a rubber bulb as used for an atomiser or enema syringe and the hole closed with tree wax or asphalt or tar and sand. The bored hole should allow the tapering nozzle of the syringe to fit closely so as to avoid a blow-back of the powder. Tea bushes in Ceylon and fruit trees in Australia are successfully treated by this method.

[*Editorial Note.*—The *Engineering News Record* of 24th August 1933 contains an article by Mr. A. A. Brown, the Chairman of the Termite Investigation Committee, which has been financed for a five-year period to the extent of about 60,000 dollars by the leading industrial concerns, public utilities and lumber associations of the Pacific Coast. The Committee's final report is still in the press, but Mr. Brown gives a summary of its general recommendations as follows :

(*a*). Construction methods for new work and for the repair of existing structures should keep all untreated wood away from contact with the ground.

(*b*). If the most complete protection from damage by termites is required, and if feasible, all wood that is placed in the ground or in contact with the ground should be impregnated according to standard specifications with chemical preservatives known to give protection.

(*c*). Wherever termite damage to wood not in contact with the ground is to be prevented, and when this cannot be done by methods of construction, and if feasible, wood should be used that has been impregnated according to standard specifications with chemical preservatives known to give protection. This applies to attack by dry-wood termites, as well as to attacks by subterranean termites through covered runways over foundations.

(*d*). Where the use-life of a structure is relatively short, or where the most, complete protection by pressure impregnation is not feasible, and where a measure of protection greater than that afforded by untreated woods of most species is desired, the Committee recommends the use of sound, seasoned heartwood of species known to be relatively unpalatable to termites. The protection secured increases with the

amount of extractive present in the wood, and the duration of this protection depends upon the retention of a toxic amount of the extractive in the wood. The loss of extractive will depend upon the degree of exposure to the elements and to soil moisture.

(*e*). The dipping, brushing or spraying with chemicals toxic or repellent to termites gives some protection, although such methods are not included in the standard specifications. The degree and duration of protection attained depend upon the initial toxicity of the substance, its permanence in the wood, its concentration in the wood, and the integrity and thickness of the protecting coat.]

REVIEWS.

REGENERATION AND MANAGEMENT OF *SAL* (*SHOREA ROBUSTA*).

BY H. G. CHAMPION AND OTHERS.

(Ind. For. Rec. Vol. XIX, Part III). Price Rs. 5/-.

One of the features of forest policy and forest management in India is their tendency to become more and more provincialised. Nowhere is this better exemplified than in the *sal* forest, which is managed by the forest officers of six provinces in six more or less watertight compartments. The wholly irrelevant fact that a temporary political expedient in the shape of a provincial boundary line happens to run through a forest may be regarded in India as quite a natural and adequate reason for practising entirely different systems of silviculture on the two sides of the line.

In earlier days this tendency was to some extent held in check by the rule that all working plans had to receive the sanction of the Inspector General of Forests. The decentralisation of the sanctioning authority for working plans has already been effected and is likely

to be followed before long by the complete provincialisation of the Forest Service. There is thus a very real danger that progress in Indian forestry will in time to come be seriously handicapped by a narrow provincialism in the outlook and aims of the forest officers.

To this disintegrating influence the latest contribution to the *Indian Forest Records* should prove a good corrective, for it combines a masterly and comprehensive survey of the experience that has been gained, the successes achieved, and the mistakes made in *sal* forest management by the forest departments of the six provinces, with recommendations for profiting in the future from their experience and experiments.

The book consists of the report that has been written by Mr. Champion after an extensive tour through the *sal* forests of the six provinces. This tour was undertaken with the approval of the Government of India and the six Local Governments for the express purpose of compiling the experience available in all the *sal* provinces in one comprehensive survey and tabulating and correlating the several types of *sal* forest. Mr. Champion was accompanied on his tour by many of the local forest officers, who, as the title page shows, have collaborated with him in the production of his report.

Mr. Champion classifies the *sal* forests into thirteen main types,—five of which he further subdivides into sub-types, making in all twenty-one types and sub-types. He explains that this classification is a tentative scheme based on inadequate study of existing types and incomplete understanding of the ecological status and interrelationships of the types separated. Nevertheless the appearance of this comprehensive classification of *sal* forest types marks such a notable advance that it will not be out of place to quote here the whole list of types as summarised by Mr. Champion in a tabular statement on pages 6 and 7.

List of Types of Sal Forest.

A.—DRY SAL .. .. Rainfall rarely over 60 inches and often under 50 inches. Mean daily relative humidity for the year under 60 and for March under 45. Soil drainage very complete.

1. *Dry Siwalik sal* .. .. (1. Dry Siwalik type).
2. *Dry Gangetic alluvial sal* .. .. (2. Dry Gangetic type).
3. *Dry Peninsular sal* .. .. (3. Dry Peninsular type).

B.—MOIST SAL .. Rainfall 55″—75″ (50″—100″). Mean daily humidity for the year 60—70, for March about 45—60.

1. *Moist western hill sal* .. .. (4. Moist Siwalik type).
2. *Moist Peninsular sal* .. .. (5. Moist Peninsular type).
   (*a*) *Moist Peninsular high level sal* .. (5a. Supkhar sub-type).
   (*b*) *Moist Peninsular low level sal* .. .. (5b. S. Raipur type).
   (*c*) *Moist Peninsular valley sal* .. .. (5c. Singhbhum valley sub-type).

   App. Frosty valley sal.

3. *Moist (Gangetic) high level alluvial sal* .. (6. High level alluvium type).
4. *Moist (Gangetic) low level alluvial sal* .. (7. S. Kheri type).
   App. Frosty sal chandars .. (7a. Chandar sub-type).
5. *Moist (Gangetic) low level clayey alluvial sal* .. (8. Old alluvium type).
   (*a*) *Moist western low level clayey alluvial sal* .. (8a. Gorakhpur sub-type).
   (*b*) *Moist eastern low level clayey alluvial sal* .. (8b. Dacca sub-type).
   App. Kamrup alluvial sal. (8c. Kamrup alluvium sub-type).
6. *W. Tarai sal* .. .. (9. W. Tarai type).

C.—COASTAL SAL .. Rainfall 55″—75″. Mean daily relative humidity for the year over 70 and for March about 70.
(10. Puri type).

D.—WET SAL .. Rainfall over 75″ (60″—200″). Mean daily relative humidity for the year 60—70 and for March 65.

1. (*Wet*) *Eastern hill sal* .. .. (11. Eastern hill type).
   (*a*) *East Himalayan sal* .. .. (11a. East Himalayan sub-type).
   (*b*) *Khasi hill sal* .. .. (11b. Khasi hill sub-type).
2. (*Wet*) *Eastern Bhabar sal* .. .. (12. E. Bhabar type).
   (*a*) *Upper Bhabar sal* .. .. (12a. Bamba sub-tpye).
   (*b*) *Lower Bhabar sal* .. .. (12b. Sivok sub-type).
3. (*Wet*) *Eastern Tarai sal* .. .. (13. E. Tarai type).

There follow two more statements, one showing the distribution of the several types and sub-types by provinces and the other giving their leading characteristics under the headings "outstanding features," "typical quality class," "chief rock and soil," "selected characteristic associated species," and "regeneration." Recognition of the types is further facilitated by a series of excellent full-page photographs taken in forests belonging to the several types.

In a chapter on "Stability of Types" Mr. Champion emphasises the fact that many of these types are not in a condition of stable equilibrium, and he draws attention to the important bearing this has on their management in the following words :—"The best treatment, above all with regard to regeneration operations, of the different types of *sal* forest is very intimately related to their status and stability as sub-climaxes or true climaxes"; and in the detailed accounts of the types which follow he discusses this question for each type separately under the heading "ecological status."

Having made his general classification of types Mr. Champion goes on to survey in general terms for the *sal* forests as a whole the past history and present condition of natural regeneration (Chapter IV), artificial regeneration (Chapter V) and management (Chapter VI). And these are followed by six chapters, one for each province, in which the regeneration and management of *sal* forests in each province is dealt with in detail for each of the forest types that occur, and suggestions are made for the consideration of the local forest officers.

Throughout the whole book there is a wealth of references to the literature on *sal* that has appeared in recent years in the *Indian Forester* and elsewhere. And Chapter XIV, which summarises briefly the contents of selected literature on *sal* published since 1919, forms in itself an invaluable book of reference for the use of all who wish to study the literature of the subject. The fact that this chapter deals with no less than eighty-five publications is in itself an indication both of the great extent of the field in which Mr. Champion has had to

work in the production of this book, and of the characteristic thoroughness with which he has tackled the task he set himself.

To sum up, Vol. XIX, Part III of the *Indian Forest Records* is at the same time an original contribution of the highest value and a much-needed co-ordinating record of the knowledge and experience of the forest departments of the six *sal* provinces; and its appearance will be welcomed as an event of outstanding importance in the history of *sal* forest research. It will also be welcomed for itself; for a good book is a good friend, and there are probably many forest officers having no aspirations to shine as research workers who, taking this book with them in camp, will thank Mr. Champion and his collaborators for introducing them to new aspects of the *sal* forest and for giving them an awakened interest in the sometimes rather too baffling problems of its silviculture.

ANON.

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It is reported that some years ago a forest officer in the United Provinces gave it as his considered opinion that the regeneration of the silver fir depended more on the will of the Almighty than on the efforts of the forest officer. Probably most officers in Bengal and the United Provinces, and possibly also in other places, would agree that this might equally well be said about *sal*; Mr. Champion's book certainly makes one think that there is a good deal in this. We should, however, remember that the scientific study of *sal* has been going on for a period which only represents a comparatively short part of the life of a *sal* tree and if we have not yet learnt what we ought to do we certainly have learnt a great many things that we ought not to do. Also, as Mr. Champion points out, we are not dealing with normal forests but with forests that had suffered severely from unregulated felling, burning and grazing for many years. Being, as I sometimes describe myself, a quick worker, I once had the time and also the inclination, to glance through all that had been written about *sal* in the

Indian Forester. For many years all writers harped on what they considered the fact that *sal* was prolific in its natural regeneration and that it was sufficient to fire protect a *sal* forest and regeneration would spring up everywhere at once. None of the earlier officers seemed to realise that this regeneration had been waiting there for many years and only required a few years' fire protection to give it a chance to come up. This successful protection is, as Mr. Champion points out, the origin of practically all of our best pole crops of to-day.

While employed on other duty I was lucky enough, owing to the kindness of forest officers in other provinces, to see a little of their *sal* forests. My chief recollections are the profusion of regeneration in parts of the C. P. and B. and O. and the excellent *taungya* work in Bengal. As I know so little about other *sal* forests I will confine my remarks to the U. P. Here, however, one great difficulty arises. Mr. Champion has been so thorough, and so careful, that short of agreeing with everything he says there is little to note on.

The classification into types is interesting and satisfactory, confining the forest in the U. P. to two main types Dry and Moist, with two sub-types in the Dry and seven sub-types in the Moist, nine in all. As our compartments in the larger divisions average roughly three to five hundred acres very often many of these types can be found in one compartment. This makes scientific management very difficult indeed and requires that the D. F. O. and also the Working Plan Officer should have a very intimate knowledge of his forest, an impossible thing for an officer who is frequently transferred. He refers to the instability of the types as they exist. Undoubtedly areas that are now classed as moist would probably many years ago have been classed as dry; progression is visibly taking place. It is interesting to see that moist *sal* forest is considered a true climax. Seeing how many of our better types of moist *sal* have failed to regenerate themselves for a large number of years it is difficult to concede this. It is, however, not easy to answer the question as to what other potential dominant is likely to displace it. A mixed evergreen forest with a heavy undergrowth or understorey of *Mallotus philippinensis* seems the most

likely, without any particularly dominant species. Places can be seen now where this seems to be happening. It is certainly necessary to check progression in the moist types during regeneration and to favour it in the dry types. The forest most easy to regenerate is, in my opinion, a potentially moist type which has been made or allowed to regress to a drier type and is then by protection, etc., slowly brought back to its proper type. With this slow progression up comes the regeneration, and this, as already stated, is really the history of most of our better forests.

Reference is made to Mr. Chaturvedi's experiments in burning *sal* seedlings in the first year. One gathers that Mr. Champion is not altogether satisfied with the conclusions drawn, although he does not definitely say so. Personally I am not at all satisfied that the mortality is such that burning one year old seedlings should never be undertaken, provided that the area burnt is of the moist type that really requires burning and that the burning is carried out at the right time of year and in a proper way. Plate 12 in the Record shows a fire-line in Pilibhit " carrying new whippy shoots. " Was this a new or an old fire-line ? *I am firmly convinced that where an area is really* suitable for burning it should be burnt annually until the regeneration is ready to go ahead, and that less damage will be done to the regeneration on the whole by doing so than by leaving it unburnt after a good year of recruitment. It is correctly stated that if fencing, rains weeding, weed pulling for many years, and the like have to be done in order to obtain and establish regeneration it is far more practical and economical to go for artificial regeneration and be done with it. Thorough rains weeding over large areas is not at present a practical proposition. I entirely agree that light (*i.e.*, not heavy) regeneration fellings coupled with annual burning and other measures should be carried out in P. B. II and that no area should go into P. B. I until it is adequately regenerated.

I am not satisfied that the " considerable price increment put on by *sal* standing after increment or preparatory fellings " would justify a long regeneration period. Last year I sold trees in such an

area and give below an abstract of the trees marked over 16″ diameter :—

		Sound.	Hollow fit.
Diameter	16″ to 20″	386	26
	20″ to 24″	63	1
	Over 24″	1	..

This was good quality forest averaging about 100′ total height. From volume tables the outturn in sawn material should have been 9,600 cubic feet. The contractor was to supply 1,530 *sal* M. G. sleepers, *i.e.*, about 2,300 cubic feet out of 9,600 as sleepers. He sawed this number of sleepers and more but could not supply 1,530 passed I class sleepers because a very large number of them had to be rejected for excessive sapwood. In this, and in another coupe with a larger number of larger trees, in an area where regeneration fellings had been made somewhat heavily about ten or twelve years ago, it was found that the trees instead of having about the usual inch of sapwood had about a three-inch deep zone of sapwood. Again this year I have sold trees in a previously heavily marked regeneration area and contractors would not bid nearly as much per cubic foot as for trees grown in a well stocked forest. The "increment" is there all right but not the "price."

A year's preliminary cultivation before afforesting with *sal taungya* may be a very good thing in moist rich soils; suchsoils need "sweetening." I fancy, however, that the real reason why this is allowed is two-fold, one because it is very difficult after the felling to get the land ready for *sal* sowing in the same year, and also largely because it is not possible to get cultivators to take on the work on any other terms. Where we have done departmental *taungya* in Jaspur forests we have allowed no preliminary cultivation but have put the *sal* in right away with cotton and *arhar*, the latter proving an excellent cover-crop as the area is fenced and so safe from pigs. Incidentally in the U. P. cotton and *arhar* do us very well and we have no need to try *Tephrosia* or other cover-crops for which we have no market.

In suggestions for consideration concerning management in type B 3, moist high level alluvium, which contains a large proportion of the more valuable forest in the U. P., the suggestion that, where only a portion of the full theoretical annual coupe can be successfully dealt with, the shortage might be compensated by felling in P. B. II is to be deprecated. The alternative suggestion to carry forward deficits to be utilized later is preferable. Under recent plans there has been considerable sacrifice of immature growing stock. I do not think that many of us have wrongly assumed that most of this would reach maturity.

In Chapter XIII "Summary of Investigations Recommended" detailed suggestions are made which cover a very wide field of work, all very necessary. The warning that "research staff and funds should be concentrated in the first place on the economically most important types and problems, and not dissipated on those of relatively minor significance" is most sound. Considering the number of years that we have been studying *sal* and its regeneration it is really amazing the large amount we yet have to learn about it. This book should help to guide us on correct lines.

W. A. BAILEY.

FOREST RESEARCH INSTITUTE TESTS ON INDIAN TIMBERS.

Reports published in Indian Forest Records, Volume X, Part VII, Volume XII, Part III and Volume XVII, Part VII.

(*Review by H. J. Nichols, Engineer-in-Charge, Broach, B. B. and C. I. Railway.*)

The extensive series of tests on Indian timbers which have been in hand at the Forest Research Institute, Dehra Dun, under Mr. L. N. Seaman during the past 12 years or so have afforded a mass of valuable data on one of the physical properties, *viz.*, strength—of

Indian timbers. It is proposed in this note to examine the results so far published, from the point of view of the user, and to make one or two suggestions to indicate the direction in which the non-specialist feels most in need of assistance in the employment of timbers for structural work, the properties of which are not yet widely known.

Tests.—Turning first to the records of the tests themselves there would appear to be no question that the method of testing large numbers of small clear specimens first, and establishing a ratio of strength between these and a smaller number of large specimens would give all the information that a user would require. In fact many of the working stresses given in tables (3-A Dicotyledons and 3-B Conifers, I.F.R.—Volume XVII—Part VII) would appear to show unnecessary refinement. There would appear to be little to be gained in stating bending or compression stresses in units smaller than 100lb. per square inch, or shear stresses in units less than 10lb. per square inch. The extremely variable nature of the timber, together with the very large human element involved in its selection, grading and seasoning, does not appear to warrant any attempt at accuracy finer than say ±10 per cent, if as close as this. Modifications in working stresses for structural grades Nos. 1 and 3 might with advantage be expressed as percentages of structural grade No. 2, say + 20 per cent for grade No. 1, and — 20 per cent for grade No. 3.

The modification proposed in the Interim Report on Project No. 2, I. F. R., Vol. XVII—Part VII, in the working stresses for beams, amounts approximately to an increase of 20 per cent in the case of dicotyledons.

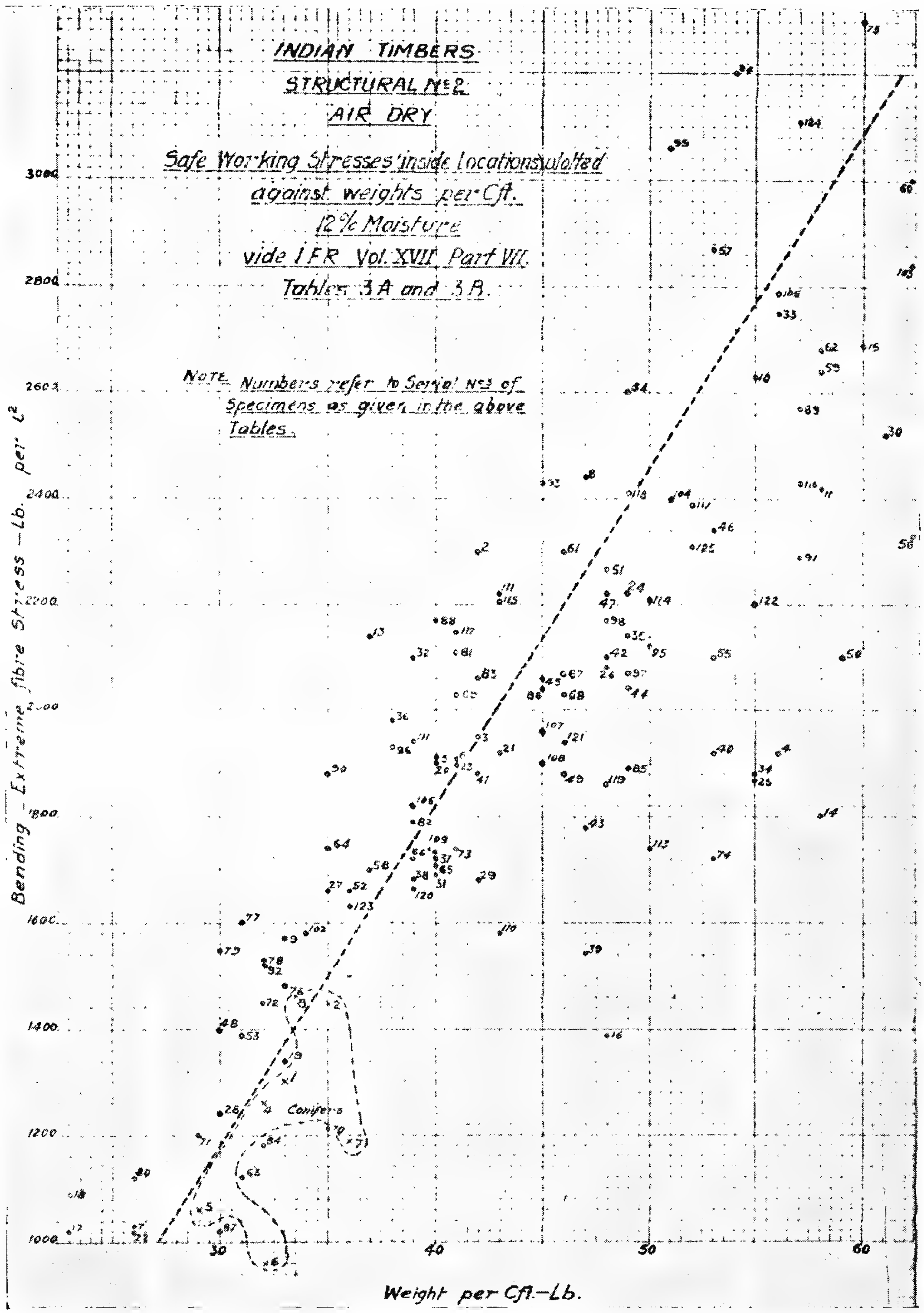
As stated on page 7 of this report, under the tentative grading rules of 1926, the worst samples of hardwoods possessed strengths from 1·87 to 5·16 times the then tentative working stresses. These figures compared with 1·03 to 3·24 in the case of conifers. After an increase of 20 per cent, the figures for hardwoods would become 1·56 to 4·30, which are still substantially above those found satisfactory in the case of conifers. It is also stated on page 6 of the same report that the average margin in the case of hardwoods was more than 20 per cent greater than the average margin in the case of conifers. Under

the revised 20 per cent increase in working stresses for hardwoods, the average margin should still be above those accepted for conifers, and it is difficult to see what objections could be raised to these proposals.

It must be admitted that if the worst specimens were selected for critical members of a structure, working constantly to the agreed safe working stress, a factor of safety of 1·56 would be obtained in the case of hardwoods and 1·03 only in the case of conifers, and a very small margin would remain to cover deterioration and accidental damage. In such members, however, no engineer would permit "worst" specimens to be used and the factor of safety would in all probability be about twice as great.

So far as the recorded stresses are concerned, it is stated in the reports that they were all obtained by loading the specimens continuously and comparatively quickly up to the point of failure. For practical loadings of this nature there can be no question that the results must be satisfactory. In probably most structures, however, timber is stressed permanently to its full load, and it would be a matter of considerable interest to know the behaviour of timbers stressed for several years to the tabulated working stresses. In Volume XII, Part III, I. F. R., page 13, it is stated that in such cases the elastic modulus should be halved; from which it is understood that slow plastic yield can be expected. Does this occur in tension or compression, or both? Also, to what constant intensity can these timbers be stressed before plastic yield becomes appreciable? Also, how was this factor of 2 arrived at, and does it apply equally to inside and wet locations? Unsightly sagging beams are of common occurrence in timber structures, a feature which suggests that this point has not received a great deal of attention in the past.

It is of some interest to compare the safe fibre stresses in bending as given in tables 3-A and 3-B, with the weights per cubic foot at 12 per cent moisture content. These have been shown in graphical form in Plate 11; the numbers shown against each point are the serial numbers of the species as recorded in tables 3-A and 3-B. It


INDIAN TIMBERS
STRUCTURAL No. 2.
AIR DRY
Safe Working Stresses 'inside Locations' plotted against weights per Cft. 12% Moisture
vide I.F.R. Vol. XVII Part VII. Tables 3A and 3B.
NOTE. Numbers refer to Serial Nos of Specimens as given in the above Tables.
Conifers
Bending – Extreme fibre Stress – Lb. per □"
Weight per Cft.–Lb.
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
30
40
50
60

will be noted that with the exception of a few specimens, there is a very fair straight line relationship between weight and working strength in bending. As a rough guide, such a relationship, which can easily be memorized, might be of use, *viz.*:—

$$\left.\begin{array}{r}\text{Working stress in lb.}\\ \text{per sq. in.}\end{array}\right\}=(63\phi \times \text{wt. etc.}) - 700$$ and would apply equally to dicotyledons and conifers.

Grading Rules.—The inspection of timber is too often left to the uninitiated, who through the absence of standards, may err on the side either of leniency or of unnecessary severity. To such inspecting or purchasing officers the grading rules would be of the greatest value, and in the form published in 1926, with the revised working stresses for dicotyledons, I. F. R., Volume XII—Part III—Appendix B, they are considered admirable. Though subject to possible further modifications, it is considered that they would be of great value in their present form to all engineers. It is suggested that they should be published in pamphlet form without delay and widely advertised for general use. Instances must occur to most engineers, in which they would have been grateful to have had the assistance of such specifications, when faced with the difficult task of passing or rejecting timber. As it would appear that some years must elapse before a final draft of these rules can be prepared an immediate issue of the 1926 draft as tentative rules would seem more than justified. In connection with these rules one small addition is suggested. The accepted working tolerances on sawn, hewn or planed timbers of various nominal sizes, if included, would be of assistance generally.

Suggestions.—It is understood that the primary object in undertaking the projects now under consideration was to make available for commercial purposes the large resources of comparatively unknown timbers in India; and the secondary object, the more economical use of all hardwood timbers by obtaining and publishing more accurate data as to their strengths. The manner in which the latter objective has been pursued has been fully explained in the reports published in the *Indian Forest Records.*

The controlling consideration which arises in the design of all structural works, such as would occur on, say, a railway, is that of lowest ultimate cost, and on this factor the decision as to the employment of materials must always rest. If conditions are such as to require the employment of timber, then the timber to be used would again be that which would ultimately be the cheapest, when all factors have been taken into account. Such factors would include :—

(1) Durability and freedom from warping and splitting.
(2) Size of logs available or maximum normal size of scantling.
(3) Immunity from insect attack.
(4) Cost per cubic foot.
(5) Strength.
(6) Ease of working.

These factors have been written down in the order of importance, which it would appear to the writer would apply to the selection of timbers for most structures ; and it will be noted that the question of strength is placed last but one. From the point of view of the practical engineer, at least for permanent work,—as against temporary construction falsework,—this list would represent fairly the relative importance attached to a knowledge of the strength of timbers, and before a selection could be made it would be necessary to obtain data under the other headings given.

It is not known to the writer if data on these points are available from other sources, but it is considered that their importance is at least as great as that of a knowledge of the accepted safe working stresses : and it would be of the greatest assistance to engineers if such data could be collected and published together with the test reports now under consideration, (Tables 3-A and 3-B, I. F. R., Volume XVII—Part VII—1933).

The question of first cost is of great importance to the user, and in the absence of some indication he might be compelled to pass over an otherwise suitable timber in favour of one of the more widely known varieties already on the market. It is, therefore, suggested in the case of timbers which are not already marketed, that an attempt might be

made to forecast a price—based on a knowledge of the localities from which such timbers are to be obtained, together with probable royalties, or costs of trees, cost of extraction, wastage, rejections, etc. On this basis it should be possible to produce an approximate comparative figure, which would at least give the user a reasonable chance of ordering from among the lesser known timbers.

Equally important would probably be a survey of forests to determine, if only approximately, the supplies of each timber available. It would be depressing to hit upon an apparently excellent timber for a certain work, only to be told later that its supply could not be guaranteed, since the resources of the forests were unknown.

Certain of the timbers given in these tables are definitely unsuitable, for various reasons, for structural purposes. Such timbers might be marked accordingly without further discussion. Others might have special qualities to suit them for use in water, and these again might be so marked.

It is hoped that these suggestions for the inclusion of additional data will not be considered in any way to detract from the admiration which all engineers will feel for the valuable work carried out by Mr. Seaman. These points are known to be outside the scope of the projects and their mention should not be considered in the light of criticism. The concise reports prepared by Mr. Seaman and published from time to time, make no mention of the vast amount of patient effort and care required in their preparation and it is fitting that such pains should be recognised and duly acknowledged.

H. J. Nichols.

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Notes on Mr. Nichols' Review, by L. N. Seaman, Timber Testing Section, F. R. I.

The review by Mr. Nichols is much appreciated, and the following notes on questions raised by him should help to clear up any doubtful points which occur to most readers.

Mr. Nichols is quite right in *stating that great refinement is not* necessary in the figures given for working stresses. In the actual preparation of the tables, however, it was not found advisable to round the figures quite so broadly as he suggests. Such a course would give, in some cases, a misleading impression of the *relative* strength of certain species. It was, therefore, decided to prepare the figures as published. It was not expected, however, that practical engineers would feel constrained always to work to the exact figure given, but would treat that figure as a basis to be modified slightly, if necessary, in the light of engineering judgment. This applies, of course, to most engineering materials. It must be pointed out, however, that there is a very common tendency greatly to exaggerate the variability of wood. Prof. Johnson in his "Materials of Construction" says, "Wood has also been considered to be a very variable material, and so it is when compared to structural steel. Tests, however, show that it is as uniform as concrete, brick, or stone." That was many years ago. With modern grading methods there is a strong tendency greatly to reduce the variability of strength found in timber fit for acceptance. Methods of mixing and proportioning concrete have been improved in recent years, but the product is probably still as variable as graded timber, and any carelessness or lack of skill in preparation causes even greater variability. Brick and stone are, of course, the same as they were when Prof. Johnson first wrote his book. It would be a mistake to allow too much latitude in figures given as safe working stresses for wood.

The published tentative grading rules (*Indian Forest Records*, Volume XII, Part III, 1926) actually give a method of adjusting safe working stresses to grades very similar to Mr. Nichols' suggestion, though the figures are not quite the same. The figures proposed in that Record were as follows :—

Grade 1 material, multiply Grade 2 values by 7/6.

Grade 3 material, multiply Grade 2 values by 5/6.

These could, of course, be expressed roughly as +17 per cent and — 17 per cent.

Several questions are raised on the topic of the effect of continuous loading, and it is possible to supply fairly definite answers to all of them. No tests on the effect of long continued dead loads have been made at Dehra Dun, but the results of work done abroad supported by the results of investigations at Dehra Dun into the influence of various loading rates, justify the following conclusions :—

(1). Permanent loading produces slow cumulative deformation, up to a point.

(2). Permanent loads producing stress in excess of the stress at elastic limit usually result in eventual fracture. Under smaller loads a limiting deflection is reached after which no further damage results.

(3). The factor " 2," applied to the modulus of elasticity when dealing with permanent loads is taken from work done in the United States of America. The slow, cumulative bending under constant load is probably to be attributed to both compression and tension to a certain extent, but also largely to a shearing deformation.

(4). The safe working stresses published in the Record are meant to make all necessary allowance for permanent loading without any further adjustment.

(5). The factor " 2 " is to be applied to the modulus of elasticity for permanent loads irrespective of the conditions of use, open air, inside, dry, or wet locations.

The relation between strength and weight has been expressed in America as an equation, which though unlike Mr. Nichols' statement is not a straight line function, differs little from it. Unfortunately the exceptions to the rule greatly restrict the possibility of giving such an equation very much practical application.

It can hardly be said that the primary object of the project which this Record reports was the introduction of unknown species of timber into commercial use. That, rather, is the combined objective of this and other projects. The primary object of this particular project is the collection and publication of reliable strength data and the preparation of rational grading rules. Information as to durability, size,

cost, etc., is to be sought in other publications of the Forest Research Institute.

At the same time it is thought that the importance of strength is placed rather low in the list. With very few exceptions no timbers are fit for use in permanent structures without suitable preservative treatment, and when this is employed the items of durability and immunity from insect attack disappear from the list altogether.

Mr. Nichols' criticisms are heartily welcomed, and his suggestions gratefully noted, though the need for economy may prevent the production of any further publications in the immediate future. However, the author takes this opportunity to thank him for his careful and helpful review.

L. N. SEAMAN.

FOREST ADMINISTRATION IN THE JAMMU AND KASHMIR STATE FOR 1932.

The Kashmir State annual report as usual appears in an attractive form illustrated by photographs, and contains much matter of interest. Its writer, Sir Peter Clutterbuck, has recently joined the Kashmir Forest Service, and the Kashmir State is fortunate in securing his services to supervise a forest estate of over ten thousand square miles of much present and potential wealth.

Conditions during the year ending October 1932 have not been easy : it is difficult, however, at the end of a record monsoon in 1933 to sympathise with Kashmir for having undergone a prolonged drought in 1932 !

Fires, mostly of incendiary origin, ravaged 90,000 acres of forest, largely as a consequence of the political upheavals in the Mirpur district. Fortunately the fires are reported to have been mainly confined to the ground cover and to have done less damage than had been feared.

The report comments on the necessity for putting back some money into the forests on regeneration measures and says that progress

is reported from all the divisions where work under the Uniform System is in force, but gives no details of the progress of regenerating the P. B. I. areas. This would be of interest to government foresters who are finding that the regeneration of extensive areas with deodar under a shelterwood involves considerable care and expense except in localities where the ecological conditions are favourable, as we believe they often are in Kashmir. We trust that we shall learn more of this aspect to Kashmir forestry in the next report.

A million and a quarter willow cuttings were planted in the Sindh and Kashmir divisions, which should soon form valuable plantations, judging from the excellent growth shown in the photo of the 12 year old willow crop published in the report.

Four lakhs of *kuth* seedlings have been transplanted which should add largely to the profitable plantations of this drug producing plant. Much attention is paid as usual to the harvesting of minor products from which a most respectable revenue of over Rs. 7,50,000 was obtained in spite of the slump. It is interesting to read that an attempt is to be made to grow all the ingredients of vegetable laxative pills in Kashmir for which there should be no lack of demand !

It is unfortunate that the working plans circle had to be abolished for financial reasons, and it is to be hoped that the State will soon be able to revive this most important branch of its administration. Kashmir is fortunate in possessing most valuable forests, and it would be a disastrous policy to curtail expenditure on the sole means it possesses of properly regulating its output of timber and thereby ensuring that its future yield of valuable timber shall not drop. In many working plans the rotation adopted for deodar is 120 years, a figure which has been found to be insufficient in the neighbouring province of the Punjab and would appear to require attention.

The slump in the timber market in the Punjab, the reduction in the price paid for sleepers by Indian government railways and the total failure of the market for fir timber have resulted in a very serious fall in revenue from Rs. 69,00,000 in 1930-31 to Rs. 38,00,000 in 1931-32 ; but thanks to a reduction in expenditure the surplus amounts

to the very respectable figure of Rs. 27,00,000. The Kashmir State has certainly pursued a very wise policy in reducing its output of timber and remitting royalties to timber traders who were otherwise likely to lose heavily on contracts taken in more prosperous times. An improvement has since taken place in the timber market of the Punjab, and as a consequence, traders have been able to bid satisfactory prices for the new contracts.

Altogether an interesting report of a good year's work on which the Kashmir Forest Department and the State are to be congratulated.

H. M. G.

FOREST ADMINISTRATION IN THE NORTH-WEST FRONTIER PROVINCE FOR 1932-33.

The area of forests at the beginning of the year was approximately 500 square miles, of which one half was formed of reserved forests under the direct charge of the Forest Deparment and the remainder consisted of village, civil and military forests.

The area of government reserved forests is small and it is evident that much of the conservator's time is taken up in the administration of border forests. It is only a short time ago that the Wali of Swat had to fight for his kingdom and it is at least a sign of progress to find that already his very valuable primæval deodar forests are managed under a working plan drawn up by an officer of the Forest Department. The Nawab of Dir "remained adamant in his refusal to accept Forest Department control in his forests :" this is unfortunate as it is understood that some of the finest deodar in Asia exists in Dir. One remembers the time some twenty years ago when Khan Sahib Munshi Imam Din, now in retirement a fter along and honourable service in the Punjab and Imperial Forest Services, was camping in the forests when opposing forces conducted a minor war round his camp—being a devout Mussalman, the Khan Sahib was fortunately saying his prayers when his camp was raided and was spaıed as being a very holy man! The report mentions that a proposed working

plan for the forests of Chitral was held up in the past for want of a free passage for timber through Afghanistan.

The conservator notes that "due to disputes amongst the local inhabitants as to the ownership of the forests (of the Kurram) no start could be made until the close of the year with the carrying out of the prescriptions of the Peiwar working plan which had been sanctioned in 1931." Clearly a mere forest officer who has never served on the border is no fit person to review the North-West Frontier Province forest administration report !

As regards more prosaic operations in government forests, the conservator notes that departmental timber operations have given place to sales to purchasers, probably a move in the right direction, but we should have been interested in the reasons. Stocks of timber extracted departmentally show a large reduction which is sufficient to account for the conversion of an average deficit during the last five years of Rs. 45,000 to a surplus of Rs. 1,21,000.

Silviculture is receiving greatly increased attention in view of the difficulties encountered in regenerating forests under recent working plans and the conservator has much of interest to record. The amount of attention now devoted to this very important work must infallibly result in an improvement in technique and augurs well for the future of the forests. The conservator has written an interesting report and the staff is to be congratulated on a solid year's work.

H. M. G.

THE GRADING OF WESTERN AUSTRALIAN TIMBERS.

(*Technical Paper No. 8, Division of Forest Products, Commonwealth of Australia.*)

In a country having an increasing export trade in any commodity it is very essential to enforce some rules which will ensure, as far as possible, a standardized product. This is especially the case with

material of a variable character such as timber. Australia is very rapidly developing her export trade in timber, and some sort of grading specifications were necessary to give full satisfaction to the customer. The present report is an attempt to prepare a set of grading rules for *jarrah* (*Eucalyptus marginata*) and *karri* (*Eucalyptus diversicolor*) which are the only timbers largely exported.

The existing specifications for export timber were examined and a field study was undertaken to investigate the present customs of the trade. The recommended grading rules and specifications were then drafted, as given in Section IV of the publication. Some modifications will, of course, be necessary, especially in the case of grading rules for building and structural timbers on the basis of strength tests. Cross grain, for instance, is not considered in this case. It may occur as the effect of a knot or a wound in the adjoining scantlings and is many times as serious a defect as the knot itself. Cross grain may also occur in sawing scantlings from a log due to a bend or twist or to the position of scantling in the cross section of the log. Some limitation to the maximum allowance of the angle of grain seems to be necessary; such an allowance is made in the case of specifications for cross arms.

The position of defects also deserves attention. A knot near the ends of a beam is not so harmful as one near the mid-span ; also a knot near the edges is more serious than one nearer the neutral plane.

While some such modifications may be necessary, the work on the whole is the outcome of careful study of the existing practice and of the requirements of the customer. It will help considerably to bring about uniformity in timber offered for export by the different mills.

V. D. LIMAYE.

TROPICAL RAIN FOREST.

After their most interesting studies of biology at the arctic limit of life, the Oxford ecologists turned their attention in 1929 to the opposite extreme of the equatorial forests of British Guiana.

In the August number (1933) of *Ecology*, T. A. W. Davis and W. Richards gave a first instalment of the results of a detailed ecological study of a small area of tropical rain forest which is of much interest to all who have to deal with this type of vegetation from whatever point of view. A sufficiently detailed account of the climate is given to bring out the marked similarity to that associated with our Indian tropical rain forest. Although no month has an average rainfall under 4″, there are six months with less than 7″ in each month in two 3-month dry seasons (February—April and September—November) which sometimes run together through the failure of the December—January rain. At the same time no month has less than 10 rainy days which is a higher figure than we can ordinarily parallel in India.

The main study consisted in a detailed examination of the growth on three plots aggregating about 4½ square chains, height, length of crown, epiphytic growth, etc., being recorded for all trees over 15 feet high over half the area, the limit being 40 feet for the other half. Analysis of the measurements shew that there are really only two distinct storeys, an irregular canopy of about 75 feet average height and undergrowth trees up to about 45 feet. Scattered trees in fair numbers up to 140 feet stand out incompletely, whilst an occasional exceptionally tall tree (belonging to a few species) has its whole crown clear above its neighbours. The stratification of climbers and epiphytes which are very abundant is mainly determined by the vertical variation in climate due to the forest itself; light intensity, not humidity, controls the height at which the different epiphytes grow.

Regeneration of the main canopy species is generally abundant and makes up two-thirds of the undergrowth layer as well as the layers below it. The tallest trees have a marked tendency to occur in groups but there is no break between them and their neighbours justifying differentiation as a separate stratum.

The extreme uniformity of climate near the floor of the forest is stressed with the resultant pronounced difference of conditions under which a mature tree and its regeneration exist.

Part II which will discuss *inter alia* the " whole question of buttressing " will be looked forward to with much interest, and we may hope that further work of the same kind will be taken up, as precise information of conditions and ecological relationships in tropical rain forest is extraordinarily scanty.

H. G. C.

INDIAN FORESTER,

FEBRUARY, 1934.

THE CASH VALUE OF RESEARCH IN FORESTRY.

To the man in the street most forms of scientific research are regarded as an expensive luxury, although there are occasional cases where a successful pioneer is given an unexpected share of limelight when his scientific toy has become the civilised world's latest necessity. It is largely owing to the educative publicity carried out by the British Association that the amazing effects of scientific research upon the world's recent history are beginning to find a place as "news", and thus a place in the ordinary man's thought. Unfortunately in India we are still far behind in this respect, for our governing class shows, with a few notable exceptions, the limitations either of a strictly classical or of a legal training, in neither of which does the student absorb those biological truths which form the basis of a scientific outlook. Neither type is in a position to appreciate fully how organised research may lead to rapid development of the country's natural resources, thereby adding to the earning power of the masses and improving their standard of living. They know vaguely that cotton and cereals can be greatly improved by crossing, and that the local breeds of cattle and horses have benefitted from importations of stock, but the far-reaching implications of research in forest matters are not generally realised.

Until a healthy public opinion has been built up amongst the educated classes with an appreciation of the economics of plantation work and the replacement of felled crops, timber treatment and seasoning, the development of our minor forest products, and of forest protection in its widest sense, our research programme will remain at the mercy of whomsoever happens to hold the purse-strings of government. How is this healthy opinion to be developed? We

have to persuade our political friends that forest research work is not the last haven of refuge of those who have failed to run a forest division efficiently, but is an essential part in the further development of our vast Indian forest estate. Research will not provide a ready-made solution for the present poor state of the timber market, but it does point the road along which we may find a way out of the present difficulties through opening up new markets and new uses for our timbers and forest produce.

As examples of concrete results obtained from the exploitation side of forest research work in India, the following may be mentioned. As a direct result of wood preservation experiments, there are now four large treating plants at work; the North Western Railway uses some 500,000 treated conifer sleepers a year, and the Assam Bengal Railway some 200,000 treated sleepers of Assam assorted woods. In this way alone millions of tons of second-class woods will be utilised which otherwise would not have found a market for years to come, while the indigenous timber trade has been encouraged in its competition against imported steel and cast-iron sleepers. Sir Clement Hindley when Chairman of the Railway Board a few years ago wrote as follows: -"The Forest Research Institute at Dehra Dun has already rendered services of supreme importance to the railways of India, but there is still a vast field of work to be covered, and there is, in fact, in the nature of the work, no possibility of it ever being finished and completed. We are, perhaps, only at the beginning of the methodical and systematic work which is continually necessary if the railways are to secure the best available material at prices which can be regarded as commercially profitable. This is one of the problems which a commercial concern such as a railway has ever before it, but it is a problem which has become accentuated by the rise of costs in all directions and the consequent need for economy. It is also a problem which, like others relating to economic working, has become more prominent by reason of the separation of railway finances from the general finances of the country, whereby the onus of producing an adequate return on invested capital has been laid on the Railway Board ....It is hardly too much to say that the potential

value of the institute to the railways is so great that if it were not in existence, those responsible for the administration of the railway on commercial lines would have to create some such organisation to take care of the scientific side of timber treatment and use."

At the Gun Carriage Factory at Jubbulpore nearly 40,000 cubic feet of timber is being kiln-seasoned in kilns tested and recommended by our institute, thus saving several thousand pounds sterling a year in degrade which occurred under the previous air-seasoning arrangements, and releasing large sums of money which had previously to be locked up in maintaining a five years' stock of *sissoo* and other hardwoods. The East Indian Railway kilns at Lillooah, also erected under the institute's guidance, can deal with 3,000 tons a year of indigenous timber, which at the rate of Rs. 100 per ton represents Rs. 3 lakhs added to provincial revenues and incidentally forms an essential step in building up railway carriage and wagon building as an indigenous industry. Kilns have been introduced also in many other places as a result of similar demonstrations, *e.g.*, Ishapore Rifle Factory, Hyderabad and other states, New Delhi government construction work, and commercial firms in Burma, the U. P. and elsewhere,—thus enabling wood users to make more economic use of the better known timbers and to develop and experiment with some of the lesser known ones.

American hickory imports worth Rs. 7 lakhs a year for sucker rods in oil boring have been replaced by locally grown *Anogeissus acuminata*. An appreciable sum has been saved to the Royal Air Force through the institute's demonstration that the life of spruce for aeroplane spars could be safely extended from 5 to 7 years. Sales of Indian made tea-chests recently increased from 40,000 to 100,000 a year in the case of one firm which sought the institute's aid in improving the quality of the glue in their plywood. The skilled modern treatment of *chir* pine resin has resulted in India becoming largely self-supporting in turpentine. From small departmental beginnings this has grown into a great industry, paying out many lakhs a year in wages to forest and factory workers in the Punjab

and United Provinces, and it continues to hold its own in spite of the increasingly strong competition from foreign synthetically manufactured turpentine.

America is now making annual purchases of 30—40 tons of the shrub *Ephedra* from India, the ephedrine extract from which is worth about Rs. 4 lakhs. Kamela powder from *Mallotus* berries now going to Hamburg is valued at Rs. 75,000 a year, and the Indian price of this article has risen from 70 to 125 rupees per maund in two years as a result of these Hamburg purchases. Improved methods in *katha* extraction from *Acacia catechu* have been adopted by the commercial firms concerned. In each of these instances our research workers have been instrumental in creating or improving these trade openings.

The use of indigenous woods such as *Bombax*, *Endospermum*, and *Sterculia* pioneered by the institute has helped the Indian match trade to find its feet against foreign competition. This trade is now bringing in a large revenue to government for these hitherto unused woods, and is the basis for a rapidly developing village industry which is now holding its own against the larger commercial match factories. In the paper trade, mills using *bhabar* grass in Northern India have raised its price so much that it pays them to import pulp, the amount imported having risen from less than 6,000 tons in 1919-20 to nearly 23,000 tons in 1930-31. The pulping of bamboo as a commercial process was worked out after many years of patient research at our institute, and is already used extensively by several Calcutta paper mills. It is only a matter of time before India will supply her paper requirements from her own vast reserves of bamboo forest.

These are some of the major points achieved on the economic side of forest research. There still remain the less spectacular but fundamentally important lines of work on the improvement and better protection of our forest estate as a whole. To produce the dead timber of commerce as and when required, we must have well stocked growing woods from which regular and continuous supplies will be forthcoming, and in which the balance of nature can be restored

directly any of the trees' ever-present enemies such as insects, fungi, or fire, combine with altered physical conditions to become an epidemic. Efficient protection and a closer knowledge of all the factors which go to make up the complexity of a growing forest are therefore essential links in the long chain of seed—seedling—sapling—mature tree—log—timber market. As specialists are considered necessary attendants upon the birth and upbringing of a human being, and not merely to decide upon the proper disposal of his corpse when dead, it is equally evident that timber must need proper care all through its development as a growing tree.

These facts should be more widely known and appreciated. The success of our research work to date, and the tremendous possibilities which it holds for the future, should be preached and advertised until the layman accepts without query the necessity for an adequate and sustained programme of research as a fixed charge on the country's liabilities. The cost of forestry research is as necessary and as logical for government to undertake as it is for any well conducted commercial firm to budget for insurance, depreciation, and the replacement of obsolescent equipment.

PRODUCER GAS FROM CHARCOAL.

A Cheap Substitute for Petrol.

By S. Ramaswami, M.A., Minor Forest Products Section, F. R. I.

When a mixture of air and steam is passed through a layer of incandescent, solid carbonaceous fuel (anthracite, coke, wood, charcoal, or carbonised peat and lignite), a chemical reaction takes place forming carbon monoxide and hydrogen, both of which are inflammable gases of high calorific value which form an explosive mixture with air. Numerous experiments have been conducted, especially in France, in utilizing this mixture of gases, now known as "producer gas," in running internal combustion engines which previously were confined to using petrol or kerosene. The success of these experiments has resulted in the appearance on the market of several types of producer gas plants or "gazogenes" as they are known in France.

In general, the producer gas plants available on the market at present are of three types :—

(1) Large stationary units developing over 20 H. P.

(2) Small portable units of 2 to 20 H. P.

(3) "Gazogene" units for attachment to motor vehicles.

The producer plant or "gazogene" usually consists of a producer and a scrubber. The former is divisible into two portions: the generator in which the gas is made and the hopper containing the solid fuel. The generator which is really a slow combustion furnace is usually provided with a refractory lining and has a grate at the bottom, the fire bars of which may be fixed or of a rocking type to prevent the formation of clinker. The generator is provided with an air tight lid which contains a small water tank and drip control feed by means of which water is fed continuously in small quantities into a vaporizer fitted to the generator. The engine suction provides the means by which water vapour and air are drawn into the generator. For purposes of starting, a fan is fitted on the top of the generator and is readily operated. The amount of water required is 0·75 gallons per 100 miles. The gas as it comes out of the generator is cleaned in the scrubber which removes smoke, acid vapours, and dust particles. If these are not removed they will reach the engine and corrode it. The scrubbers in modern "gazogenes" are so efficient that there is no danger from corrosion, if proper attention is paid to the scrubber every day. The purified gas controlled by a throttle instead of, or in addition to, the petrol throttle. is fed into the motor engine and drives it like petrol.

On changing over from petrol to producer gas there is a loss of power amounting to 30 to 40 per cent.; but this is obviated by using a special cylinder head so as to obtain the higher compression necessary with producer gas. This cylinder head is supplied by the manufacturers of "gazogenes" and can be easily fitted to a petrol engine, and an engine so fitted is equal in performance to a petrol engine.

As already mentioned, raw wood can also be used in a "gazogene" instead of charcoal. Hardwood, thoroughly dried and free from

bark, is preferable : but the labour and cost of converting it into small pieces, 2 cm. × 2 cm. × 3cm. will probably be too much to make it an economical proposition. Moreover, wood produces a lot of acid vapour and tarry products which would have to be thoroughly removed in the cleaner, thereby complicating matters.

In 1930 and 1931 some practical tests were carried out on behalf of the Imperial Institute, London, by the manufacturers of a producer gas plant, using charcoal from different species. The same lorry carrying the same load for the same distance was used in these trials, and the run was over the same stretch of road so that the gradients were the same for all runs. Each of the samples of charcoal tried proved to be quite satisfactory for use with the producer plant in question, but charcoal from mixed woods was found to be the best. In general it may be stated that hard dense charcoal when broken up makes less smalls and dust than soft light charcoal and both smalls and dust have to be removed before the charcoal is put into the hopper. Dense charcoal also gives a greater weight of fuel for the cubic contents of the hopper space, with the result that the distance covered per hopper charge is greater than in the case of lighter charcoal. Charcoal made from laurel (*Terminalia tomentosa*), *sal* (*Shorea robusta*), *babul* (*Acacia arabica*), *kandi* (*Prosopis spicigera*) and similar hardwoods should, therefore, be eminently suitable for the purpose. Soft light charcoal, like that of mango could also be used, but in such cases the hopper will require replenishing more often.

From actual experiments carried out under conditions similar to those in India, it has been demonstrated that an annual saving of two hundred pounds sterling per bus per annum could be expected by the substitution of gas produced from charcoal for petrol in the case of an average passenger service bus. A more direct calculation is exemplified by the following figures : a loaded bus mounted on a 30 cwt. Ford chassis would consume approximately seven gallons of petrol for a hundred mile journey. With fuel costing 1·4 rupees per gallon, this would amount to an expenditure of 9·8 rupees on petrol. The same journey could be completed on one maund of charcoal costing approximately one rupee, showing a saving of practically

8·8 rupees per hundred miles. A plant for such a purpose can be purchased complete, including the new cylinder head, for somewhat less than £100/- (according to the *Indian and Eastern Engineer*, November 1932). (*Note.*—The above price has since been reduced and plants are now available complete with piping, fitting, brackets and control for from £50/- to £100/- each, according to size—*The British Trade Journal and Export World*, November 1933, p. 1004).

The disadvantages of using producer gas are :—

(1) The time required to start (about 10 minutes). This does not really matter for heavy transport work, for agricultural tractors, portable air compressors, small marine engines and lorries or buses making long journeys. This delay in starting can, moreover, be obviated by starting the engine on petrol and then switching it on to producer gas.

(2) Charcoal is bulky compared with petrol and requires more storing space. Converting charcoal into small briquettes solves this problem, but it has been found in France (the home of "gazogene" plants) that briquettes are not always economical as the briquetting plant has of necessity to be stationary and it does not always pay to get charcoal from different places for briquetting in a central factory.

(3) The useful load of a lorry is reduced by about 2½ to 4 cwts. on account of the weight of the "gazogene" plant.

(4) The scrubber (cleaner) requires daily attention.

(5) The driver may have to be paid higher wages for looking after the extra gas plant.

(6) The cost of the "gazogene" and its depreciation have to be taken into account in all calculations for purposes of comparison with petrol.

In all recent references in the press to "gazogenes" the fact is mentioned that by changing over from petrol to producer gas the fuel cost will be reduced by 90 per cent. It must be pointed out, however, that the economy to be realised will not be so large as these figures would seem to indicate, as fuel accounts for only about 40 per cent of the total cost of running a lorry.

(7) The difficulty of transporting charcoal long distances on account of its bulky and friable nature.

Even taking into account all these facts, it should be an economical proposition to change over from petrol to charcoal, especially in India where charcoal is usually readily available locally at cheap rates while petrol is very costly. In districts far away from ports, the price of petrol is now very high indeed and in such localities a "gazogene" should prove distinctly profitable. In tea estates where charcoal could be made locally using portable charcoal kilns, a "gazogene" engine should be very useful for pumping water and running machinery.

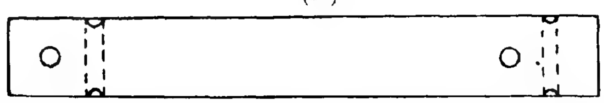
Vehicles operated by "gazogenes" are being extensively used now in French Colonies and in France. They are used also to some extent in parts of Australia and Africa. Farm tractors and lorries operated by producer gas are manufactured by a British firm* who can also supply plants for small stationary engines, portable air-compressors, etc.

A ROLLER WINCH USED IN BURMAN VILLAGES.

By U. Kantaya, S.D.F.O., Kado.

The illustration shown below is a roller winch commonly known in Burmese as a *set tone* Although it is a very common object, yet its efficiency is often overlooked. It is generally made from timber which is light and that does not split easily such as *shaw* (*Sterculia* spp.), *kathit* (*Erythrina* spp.), etc. The smaller the diameter, the easier to work. The length may be any convenient one.

(A)



Two holes are drilled at right angles to the axis at both ends but at different planes, large enough to admit an end of a crowbar or any other rod used as a lever.

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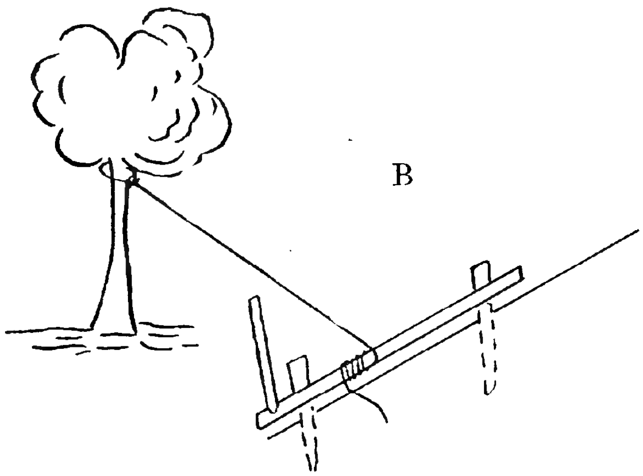
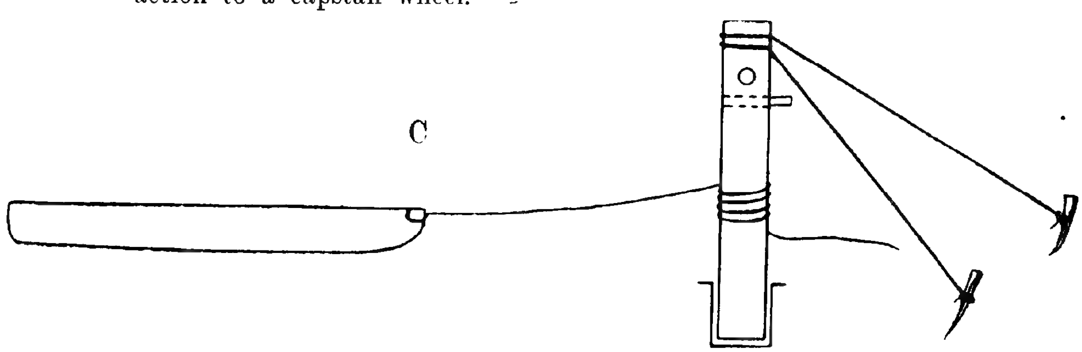
* The Producer Gas Plant Company, 62, Conduit Street, London, W., England. The marketing is done by The Koela Producer Gas Plant Co., Ltd., London. Messrs. D. Waldie & Co., Calcutta, are the Representatives of the above-mentioned firm in India.

By placing this roller against two firmly driven pegs and coiling about five rounds of an end of a rope and by rotating the roller by the aid of crowbars a considerable pulling force is exerted at the other end of the rope. Illustration "B". The pulling force should be at right angles to the roller.



When it is required to drag logs, etc. This log pulley may be placed in a vertical position by setting it in a hole dug about 1½′ to 2′ deep in the ground. The top end should be supported by guy ropes as illustration C below.

Very often a short wooden peg is inserted into the drill hole end, the roller is rotated by a crowbar with the aid of a small loop of rope running around the trenail and crowbar. This gives more leverage and the crowbar can be made free from the guy ropes as the free end can be easily lowered or raised while at work. Thus it is similar in action to a capstan wheel.



Do not allow the rope to overlap as any increase in the diameter of the pulley is bound to decrease the force.

I have tried this for felling trees in any desired direction and for moving logs. This contrivance is bound to be useful in improvement felling and thinning operations.

ANDAMAN FORESTS AND THEIR REPRODUCTION.

BY B. S. CHENGAPA, P.F.S.

PART II.—ARTIFICIAL REPRODUCTION.

Past History.—The Andamans Forest Department came into existence in 1883, and for its immediate activities, took over 156 sq. miles of these forests in the neighbourhood of Port Blair. Though its expansion was then, as it is still, limited to the amount of convict labour available from time to time, true to its tradition, it paid its first attention to silviculture and opened the same year, a *padauk* plantation, five acres in extent including a mixture of teak—an exotic—over two acres.

From the very outset various methods, both artificial and natural, were tried from time to time to raise *padauk* and teak. *Gurjan* and others were also tried, as these lesser timber species began to feel their way in the world markets. Attempts at raising mangrove date from 1897 mainly for the purpose of creating a source of fuel supply for the settlement. Since 1916, however, owing to the difficulty of obtaining satisfactory reproduction of important species, experiments were made with clear felling and artificial reproduction, and in 1921 the conclusion arrived at was : " Artificial reproduction is so easy and is so much more reliable than natural reproduction, that the latter is not of such vital importance as the former. In such cleared places the growth of weeds and more particularly of creepers is exceedingly profuse and this is a strong reason for resorting to artificial means " (Annual Administration Report for 1921 para. 30 and Summary of Progress during 1914-15 to 1918-19 para. 13). Artificial reproduction therefore became the rule and natural reproduction became " one of interest mainly in guiding artificial efforts " (A. A. R. for 1922) until 1931 when the latter was given a fillip once again and with success.

Methods tried.—Sowing broadcast over the whole area or over strips 3′ to 6′ wide or dibbling 2 to 5 seeds or pods at each stake, and planting seedlings raised in nurseries or obtained from the

adjoining jungle, were tried over extensive areas after clear felling and burning, and also over strips 20′—40′ wide cleared of all vegetation with an intervening unfelled belt of jungle 80′—200′ wide. Those sown or planted in these strips with a belt of jungle in between failed completely, while those in other areas are of varying success according to the method adopted and the species tried.

Root and shoot cuttings of *padauk, white chuglam, white dhup* and *papita* were tried in 1932. Though *padauk* and *white chuglam* sent out shoots, the results did not justify their extension. *White dhup* and *papita* stumps died out completely.

Species tried.—Of timber species teak, *padauk, pyinma, koko, gurjan, white chuglam, white dhup, toungpeinne red bombwe* and *black chuglam* were tried.

Teak (*Tectona grandis*).—Though an exotic teak was one of the first species tried in the Andamans. Seeds were obtained from Burma from time to time and were sown direct or in nurseries after treating them in various ways. From 1883—1916 parboiled seeds were dibbled three to five at a stake 3′ × 24′ in 1913 and 1914 and 6′ × 3′ and 12′ × 6′ in 1916 in Wimberleygunj early in May. Germination took place a month after and was profuse. In 1918 seeds were soaked in cowdung water for 24 hours and dibbled in October 9′ × 6′ in Bomlungta. Germination was poor and the seedlings died in the hot weather. In 1920 seeds were dibbled 6′×6′ in Bomlungta in May without any treatment, but they failed to germinate: *padauk* was therefore planted. In 1921 June and July teak seedlings had come up in profuse numbers and were fast competing with *padauk*. The *padauk* was cut back. Seeds stored in a shed for one year and then sown failed to germinate. In 1928 and 1929 seeds were soaked in running water for 24 hours and then buried in a pit 1′ deep for 3 days. All such seed dibbled in May and June 1″ to 1½″ deep germinated well, but those sown shallow died out. Spacing in this case is 6′ × 6′. Basket plants and transplants from nurseries were tried with success in Bomlungta in 1919.

Except for 18 acres grown pure in Bomlungta and Long Island, teak was raised in Wimberleygunj in a mixture mostly with *padauk*

Photo B. S. Chengapa. Teak Plantation of 1887, Wimberleygunj (Andamans.)

either sown broadcast between the lines of teak or planted in alternate lines and to a small extent with *Casuarina*, *padauk* and *koko*, and *padauk* and *pyinma* in 1913 and 1914. These were sown broadcast between the lines of teak. In its early stages the development of teak is very fast, reaching an average of 14′ in 12 months. In the third year there is a distinct falling off in its height growth. *Padauk* and *koko* catch up teak then and suppress it in the fourth or fifth year. These therefore do not make a good mixture unless the teak is specially favoured in subsequent cleanings and thinnings. *Casuarina* germination was poor.

Teak in the Andamans at first grows into weedy poles with only a few tufts of leaves at the top and with no branches. The plantation of 1883—89, now one of the best in the Andamans and as good as any found elsewhere, were then considered abortive (A. A. R. for 1885-86). The average girth and height are now 3′ 3″ and 80′ ; best girth is 4′ 10″.

These plantations (1883—89) are raised on *padauk* soil undulating ground with coarse rubbly sandy loam. Those planted elsewhere—on hills with stiff clayey soil that originally supported hill evergreen (in Wimberleygunj) and also on drained alluvium that originally supported a low evergreen type of vegetation (in Bomlungta valley) have failed. Though they grew up vigorously in their early stages, they have now become stunted and stagheaded and the trees blown down by wind reveal a very superficial root system. Pure teak raised in Long Island in 1927—29—not a typical *padauk* soil—is not very promising now. Further attempts to raise this species have therefore been discontinued. Teak has so far been successful only in areas clear felled and burnt. In 1927—29 field crops of sugarcane and Indian corn were tried with success ; sugarcane cuttings were planted 6′ apart and Indian corn 2′ apart.

Padauk (*Pterocarpus dalbergioides*).—*Padauk* is one of the first and the most extensively cultivated species of the Andamans. Its fruit, a samara, is collected in March and April mostly by taking advantage of felling for extraction. It was first tried as mentioned above in 1883 and before the end of 1889 very successful plantations

71 acres in extent,—31 pure and 40 mixed with teak,—were raised after clear felling and burning the original jungle and planting transplants from nurseries. The planting distance was 9′ × 4′. In the case of mixtures, a row of teak alternated with a row of *padauk*. The average girth and height of these plants are 5′ and 100′, the best girth is 7′ 2″.

Between 1889—1895, 1,771 acres of *padauk* and teak were similarly planted out on similar soil in lines 20—40 feet wide with a belt of jungle 80′—200′. In the early period teak and *padauk* alternating in the same lines was tried but these species were later planted in alternating lines as it was feared that the teak would suppress *padauk*. In 1903 an exmination of these areas revealed the fact that almost all of the area had reverted to useless jungle. Therefore much of this area was clear felled, burnt and planted up again with *padauk* in 1904-05. Some of the teak trees still found in this area are 3′ in girth and are badly shaped.

Between 1903—1912 about 1,300 acres in Wimberleygunj valley were clear felled and burnt, three to five pods were dibbled in May and June at stakes 6′ × 6′ except in 1906-07 and 1910 when 10′ × 4′ and 12′ × 3′ spacings were adopted.

Temporary nurseries were opened in every area to fill up blanks with transplants. It was grown pure except in 1904 when *pyinma* to act as a nurse was sown broadcast between the lines of *padauk*. In 1907 hill paddy, sesamum and cotton seed obtained from Burma were sown. Paddy was successful and continued to be sown until it was discarded in 1912, when it was discovered that grass invaded the area immediately after the removal of paddy and choked the seedling crop. Paddy also was becoming increasingly heavy and found to be damaging the young plants. The yield of paddy was 235 lbs. an acre.

Germination of *padauk* was poor. Pods were therefore exposed to rain for a week and then sown. This raised the percentage of germination from 15 to 60. Between 1913—26, 682 acres of *padauk* in a mixture with teak, *koko* and *pyinma* were raised in Wimberley-

gunj and Middle Andaman after clear felling and burning the original jungle. *Padauk* pods were sown broadcast between the lines of teak or over strips 3′ wide 22′ apart. In 1920, however, pure *padauk* was raised in Sinkan over 138 acres planting seedlings from nurseries, the planting distance being 3′ × 30′. In 1921 *taungya* was again contemplated, but the experiment tried in Bomlungta and Rangat in 1925 proved a failure as the paddy was attacked with blight and men also did not come forward for this work. On *padauk* soil this area is fairly successful but on swampy ground and on higher slopes of the hills *padauk* has failed.

Between 1926—1933, 315 acres of *padauk* were raised in Long Island and Sound Island. In Long Island pods were dibbled 6′ × 6′ in May. Germination was poor and pods were therefore soaked in water for 24 hours and after mixing with cow dung were buried in pits for 30 hours and then sown direct. This however did not raise the germination percentage by much. In 1929 pods were soaked in water for 48 hours and sown in nursery beds in May. Only germinating pods were put out in the planting area. In Sound Island seedlings of not more than 2 or 3 leaves, preferably with only cotyledon leaves obtained from the adjoining jungle, were planted out. In both the islands sugarcane and Indian corn were raised with success between the lines of *padauk*. Sugarcane seems to have the good effect of nursing the young *padauk* while keeping down weeds. In Long Island numerous plants of *Carica papaya* came up from self sown seeds, crows being the means of this sowing. These afforded considerable shelter to the *padauk* plants.

The Sound Island and a part of the Long Island plantations are quite successful and are fully stocked. The 1926—28 plantations were thinned in 1931 and 1932. About 112 acres in Long Island were ruined by deer and especially the rampant growth of *Eupatorium odoratum*,—an exotic that is now fast invading all clear felled areas in these islands.

Padauk germination in every case was slow, uneven, uncertain and continued throughout the rains. Blanks had to be filled up with seedlings obtained from the adjoining jungle or raised in nurseries

Better success was obtained by burying *padauk* pods in pits for three days after soaking them in water mixed with cow dung and sowing them direct in lines or in nurseries, and also by alternately soaking and drying the pods for two or three weeks and sowing them direct when germination was secured. As however the establishment of the seedlings early in the rains is one of the main contributory causes to the success of a plantation, direct sowing was ruled out by the Chief Forest Officer (then Mr. Mason) in 1929 and transplanting seedlings obtained from the adjoining jungle or reared in nurseries was advocated (A. A. R. for 1928-29, para. 15).

The development of *padauk* in the first two years of its existence is slow compared with other Andaman species. It grows much faster than *gurjan* and reaches an average of 3′ to 4′ in 12 months and about 8 feet in 24 months, though individuals may reach 12 or 15 feet. In the third year it shoots up pretty fast and has been found to overtake and suppress teak in its fifth and sixth year. In Bomlungta *padauk* transplants were put out in 1920 in an area where teak sowing was thought to have failed. Teak however germinated a year after. As this was mainly an experiment with teak, *padauk* was ruthlessly cut back until the teak was well ahead. This area is now completely stocked with *padauk* and has suppressed teak. Average *padauk* is now 3′ in girth and 60′ high while teak in the same area is only 2½′ in girth and 50′ in height.

Thorough and constant weeding has been found injurious and much retards its height growth. It seems to enjoy the struggle with other species but loves the leading shoot to be free. In the thoroughly weeded pure *padauk* area, it has been found that a weevil rings the leading shoots of plants two-three years old and makes them grow bushy. Three weedings in the first year, two in the second, and one and occasionally two in the third year, have however been found necessary. Cleaning, including climber cutting, has been found of great importance for about ten years, the frequency depending upon circumstances. The best and the most successful plantations 1903—11 are those that have been cleaned from their fourth year up to 10th or 12th year, the operation being repeated every second year and

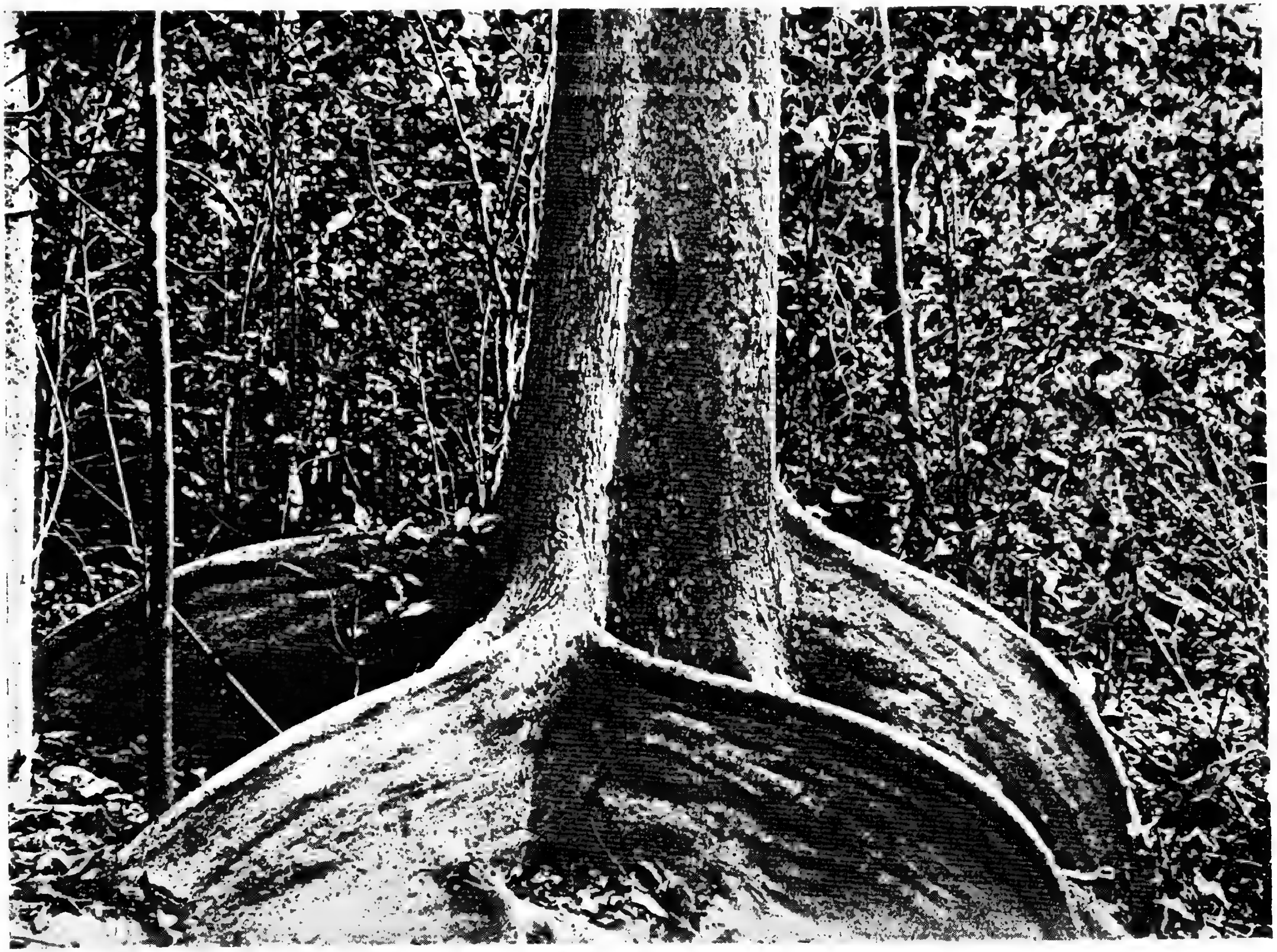


Photo H.G. Champion, Jany. 1930.

Pterocarpus dalbergioides. Buttress formation in trees 26 years old. 1904 Plantation near S. P. 3. Bomlungta, S. Andaman.

in some cases every year. Neglect in this direction has ruined many of the otherwise very successful plantations like Thitmin, Boom and part of Sinkan.

Thinnings must be carried out systematically. The younger plantations in Long Island planted 6′ × 6′, 6′ × 3′ and 8′ × 3′ had to be thinned at the age of four-five and probably this operation may have to be repeated every five years until they are about 30 years old. Plantations 25—30 years thinned fairly heavily between 1926—31 now show that the next thinning need not be carried out earlier than 1936—41.

Padauk has a decided tendency to branch low and even plants one year old are no exception to this rule. A closer planting is therefore indicated. In Sound Island 8′ × 4′ was found too close and 10′ × 5′ was therefore adopted. South and Middle Andaman plantations however show that planting 6′ × 6′ and frequent cleaning and thinning are necessary to produce the clean and straight boles 40′—60′ height that we find in some of the Wimberleygunj plantations. In many of the wider spaced plantings, pruning had to be carried out.

Various mixtures of *padauk* and other species were tried from time to time. Teak gets suppressed and therefore does not make a good mixture. *Pyinma* grows much faster and in the 1904 plantation where it was tried as a nurse to *padauk* it has suppressed the latter and forms many pure patches even though *pyinma* interfering with *padauk* was cut back in the early stages. *Koko* and *padauk* sown broadcast in 1913 show that these two species can be grown in mixture. Although *koko* trees are well above *padauk* there appears to be no undue competition between them.

Pure *padauk* has been grown in the past with success and it is the rule since 1929. Though a weevil has been known to attack the young plants grown pure, this has been overcome by making the weedings light and frequent. As the ground is always covered with a dense mass of evergreen undershrubs in all plantations whether pure or mixed, the question of the deterioration of the soil may be ignored in

these islands. Deer eat it voraciously and though only four or five of them were introduced in 1917 they have increased in enormous numbers and have almost ruined the Long Island plantations. Paroquets destroy the seeds when they are tender.

Pyinma (*Lagerstroemia hypoleuca*).—This species was first raised in 1904 as a nurse to *padauk* and was found unsuitable as it grew so much faster than the latter. Though it has exercised a decided influence in mutually shaping the boles of the young crops. it has in many places formed pure patches, killing out or suppressing *padauk*. *Pyinma* has so far been tried on drained alluvium and on undulating *padauk* soil and has not known a failure. It does well on the alluvium and on the lower slopes of hills but grows stunted and in many cases has failed on the higher slopes.

It seeds profusely every year. Plants four or five years old produce fertile seed. Germination per cent is very high and sowing direct or otherwise has done very well. Its growth is very fast and reaches 10′ or 12′ in 12 months. In 30 years it reaches about 70′. The *pyinma* trees have divided and branched low in Long Island where the planting distance is 6′ × 6′. A closer planting is indicated.

Koko (*Albizzia lebbek*).- This was first tried in 1913 in Wimberleygunj along with *padauk* and teak. *Padauk* and *koko* were sown broadcast over the whole area over soil that originally supported a *padauk-gurjan-koko* association. *Koko* germinated profusely and has been growing very well and has outstripped teak and *padauk*, reaching a height of 70′ and a girth of 35″. It was tried pure in 1920-21 in Sinkan and in 1927 in Long Island on soil that originally supported *koko*. Seeds were sown broadcast over strips 3′ wide 22′ apart in Thitmin. 6′ wide 30′ apart in Sinkan, and dibbled 6′ × 6′ in Long Island. They germinated very well but in every case caterpillars attacked the seedlings successively for two years and killed them outright except where weeding was not thorough. They push their way through in an extraordinary manner even through thickets of *Eupatorium*. In Long Island a small area was clear-felled in 1919-20 for planting coconuts. *Eupatorium* quickly invaded the area and occupied

the area exclusively. In 1929 small sickly looking *koko* plants were seen struggling through the thickets of *Eupatorium*. They are now about 25' high, very healthy and well out of the reach of *Eupatorium* but in every case they are badly shaped with numerous branches low down. Nothing was done to help them through. Pigs and deer are a great source of trouble, pigs uproot the seedlings and deer browse them heavily. It may therefore be taken as conclusive that *koko* cannot be grown pure. It makes a good mixture with *padauk* and possibly with other species as well.

Gurjan (*Dipterocarpus spp.*)—It is not known what species were actually tried,—possibly *D. alatus* and *D. grandiflorus*, as these are the most common in these Islands. *Gurjan* is one of the most refractory of all the Andaman species. Attempts to raise it either by sowing direct or by planting has not been attended with any success in the past. In 1917 seeds were soaked in hot water until the water cooled down and then put out in nursery beds. Germination was very poor. It was again tried in 1919 on a hillock and also in drained alluvium near Bomlungta,—localities that originally supported *gurjan*. After clear felling and burning the original jungle, seeds were dibbled 5 at each stake 4' × 22'. They failed to germinate, and seedlings from the adjoining jungle were planted and they also failed. In 1920 *gurjan* seeds were sown broadcast over 24 acres in Sinkan after clearing and burning the original jungle: this also failed to germinate. In 1927 seeds were dibbled 5 at a stake 6' × 6' in Long Island in a typical soil for *Dipterocarpus alatus*. They failed to germinate, and transplants from the jungle also failed.

Gurjan flowers and fruits every year and profusely once in two years, this periodicity differing from place to place. Paroquets in thousands destroy them when the fruits are tender. The few that escape this destruction fall to the ground and germinate in June and July in natural conditions. They stand shade to an extraordinary degree and unless badly smothered by weeds and climbers, they struggle through and grow into trees. It is one of the few Andaman species that is represented in all its age classes, though not indeed to the desired extent. It is immune from the attacks of deer.

White Dhup (*Canarium euphyllum*).—*Dhup* has been another difficult species to raise artificially. In 1920 seeds were buried in wet ground for a month and then sown in lines in Sinkan with *padauk* in mixture on an area clear felled and burnt. Seeds germinated fairly well and the plants outstripped *padauk* in their early development. In 1921 both treated and untreated seeds were sown in Thitmin and Bomlungta valley. Untreated seeds failed to germinate but seeds treated by immersing them in stagnant water and mud for three weeks and then sown in a nursery bed germinated in a week. In 1927 seeds were dibbled 6′ × 6′ in Long Island over one acre without any treatment; they failed to germinate. In 1929 it was again tried in Long Island over five acres. Seeds were put in a gunny bag and the whole bag was immersed in water for five days. These were sown in a nursery bed and also dibbled 6′ × 6′ in the planting area. About 50 per cent of the seeds germinated a month after, but most of them died out in the hot season. There are now about six plants and these have reached 15′ in height.

Dhup flowers and fruits every year though not profusely. Seeds fall on the ground in January and February and owing to the hard testa germinate throughout the rains in their natural condition. In areas burnt in March and April, seeds germinate in June, and before the end of December reach a height of 6′ and in 24 months a height of 15′ under suitable conditions, *i.e.*, a light overhead shade and freedom from weeds and climbers. They generally grow clean and straight, and unless the leading shoot is destroyed they have no tendency to branch low down. I have never seen a tree above 3′ in girth coppicing. Deer eat them voraciously.

Taungpeinne (*Artocarpus chaplasha*).—This species was tried in 1919 and 1921 on drained alluvium in Bomlungta and Thitmin. After clear felling and burning the original jungle, seeds were dibbled 4′ × 22′ in Bomlungta over 15 acres, and sown broadcast over strips 3′ wide and 22′ apart in Thitmin over five acres. Germination was profuse and their development was good except in places of bad drainage. Transplants also succeeded well, but big and sturdy plants suffered considerably from the attacks of a borer that destroyed the

leading shoots. Small plants and those not well weeded were found to be immune from this attack. Elephants are especially fond of this tree and swarmed round from an adjoining extraction camp and destroyed these two plantations. It is however very tenacious of life and the stumps of the plants destroyed by elephants in Thitmin in 1922-23 are still sending out weak shoots though under a thick canopy of soft-wooded trees and climbers. These trees and climbers were cut out in 1932. The result is not very promising.

Red Bombwe (*Planchonia andamanica*).—This was tried in 1919 in Bomlungta and again in 1921 in Thitmin after clear felling and burning the hill evergreen jungle. In 1919 seeds were dibbled five at a stake 4′ × 22′ over six acres. Seeds failed to germinate and the transplants from the jungle also failed. In 1921 seeds were sown broadcast over 20 acres in strips 3′ wide 22′ apart. Germination was very good and the seedlings reached 12″ in three months. They were later neglected and the whole plantation failed.

Blac' Chuglam (*Terminalia manii*).—This was tried in Bomlungta in 1919 on *padauk* soil as this is an associate of *padauk*. Seeds were dibbled 3′ apart in strips 6′ wide and 22′ apart after clear felling and burning the original jungle. Seeds failed to germinate.

Black chuglam fruits every year profusely in September-October and under natural conditions its seeds germinate freely in June and July and sometimes in November and December. Free from weeds and under light shade they establish themselves and grow into straight clean poles.

White Chuglam (*Terminalia bialata*).—This was first tried in 1919 in Bomlungta. Seeds (winged fruits) were sown broadcast over strips 5′ wide and 22′ apart. In 1920 and 1921 in Sinkan and Thitmin they were sown broadcast over the whole area and in 1926—29 they were dibbled 6′ × 6′ in Long Island and Sound Island. In every case the area was clear felled and burnt before sowing. Germination was easy and profuse and their subsequent development has been very good. They reach about 7′ or 8′ in 12 months. They generally grow clean and straight and can be grown at a wider spacing than 6′ × 6′.

This species bears fruits profusely every year and they are ready for collection in February—April. Under natural conditions on a clean ground floor, they germinate profusely, 10 to 12 thousand seedlings an acre: and if kept free from weeds and sufficient light is allowed they grow very fast. Plants three to four years old which had been planted 6′ × 6′ had to be thinned. Deer is the only enemy I have known so far. A caterpillar occasionally attacks the young leaves of plants two to three years old, but damage from this is negligible.

Exotics tried.—Besides teak, other exotics, *Swietenia mahogani* in 1899, *Afzelia palembanica* with mahogany in 1907 over eight acres, *Casuarina equisitifolia* with teak in 1913 over 52 acres, *Eucalyptus rostrata* and *E. tereticornis* in 1914 over 15 acres, *Albizzia moluccana* in 1915 over 32 acres, and *moluccana* with *Eucalyptus* in 1915 over 38 acres—were also tried with indifferent success. Germination of *Casuarina* was poor and the few that came up are still found in Wimberleygunj growing fairly well. *Eucalyptus* germinated well but after two years died out completely. Three or four trees however from nursery beds made on drained alluvium have now grown to a height of 60′ or 70′, *Albizzia moluccana* was successful and have now grown into good sized trees. All exotics except teak have been discontinued since 1915.

Total area and cost of these plantations.—By artificial means fairly successful plantations totalling 1,744 acres of pure *padauk*, 113 acres of teak and *padauk*, 18 acres of pure teak, 19 acres of pure *pyinma*, 25 acres of *white chuglam*, 14 acres of *white dhup* and 210 acres of other mixtures (total area 2,139 acres) were raised at a cost varying from Rs. 50/- in the early period to Rs. 150/- an acre in the latter period (1927—32) for formation alone. In the early days plantations were confined to areas cleared of all growth for fuel and timber and the convict labour was allowed rations only and annas twelve a month to approved men. Since 1925 however these convicts were allowed Rs. 12/- a month and over and above this a generous family allowance if they imported their families. Free labour also was imported at Rs. 30/- a month in addition to their railway and steamer fares. Areas now selected for treatment are mostly high forest with only a few

marketable trees removed. Weeding has become more costly as *Eupatorium odoratum* has run rampant in some islands in addition to the already heavy and prolific growth of weeds and climbers. In several of the islands also the deer have so increased and multiplied as to be a real nuisance for there are no carnivora to keep their numbers within bounds.

(*To be continued.*)

THE RAB METHOD IN NORTH CUDDAPAH.

By S. Raghunatha Rao, I.F.S.

Rab is a Marathi word meaning "cultivation." It connotes in forestry practice the piling up of slash wood resulting from fellings of standing trees, either in circular heaps or in long lines. The piles are well pressed down so as to give a hot burn and kill the grass on the ground. The resultant ash is utilized for regeneration work by mixing it with the soil.

Climate.—The heat in North Cuddapah is excessive in the months of April and May when the temperature goes up to over 110 degrees Fahrenheit and from January to March it is seldom below 90 degrees. The annual rainfall is between 20 and 35 inches; the bulk of it is contributed by the south-west monsoon from about the middle of June to the end of August and the rest by the north-east monsoon from the beginning of October to the end of November.

Soil.—The soil is generally a deposit of disintegrated shale. The geological formation of the district is undefined, but it is believed to be a continuation of the Deccan Trap. In places the soil is sandy loam and in others it is gravelly and is characterised almost everywhere by quartzite pebbles of varying sizes. The soil is not of good depth.

Description of Crop.—The forests of the district are of the mixed, deciduous, irregular and open type characteristic of the arid tracts. In the plains they consist to a large extent of thorny species many of which belong to the Leguminosae. The hill slopes, hill tops and plateaux contain species such as *Pterocarpus santalinus*, *Pterocarpus*

marsupium, *Anogeissus latifolia*, *Terminalia tomentosa*, etc. *Dolichandrone crispa* is a species that is common in the division and one which is of special merit for *rab* regeneration.

The necessity for artificial regeneration.—Due to scarcity of rainfall and excessive heat, there is very little moisture in the ground to enable natural seedlings to withstand drought. Besides, the presence of a rank growth of inflammable grass, known locally as *botha*, even while semi-green, is a menace to natural regeneration. Barring the plateau forests, the general crop is degraded and very open as a result of annual fires.

Rab—a solution to soil infertility.—The resultant ash of a *rab* is to be regarded as a valuable manure in the cultivation of any crop; ash mixed with the sub-soil is found to materially help artificial regeneration. Ash in quantities larger than the "optimum" (*vide* experiment carried out and described below), has been found to have the effect of giving little or no germination. When soil-working is resorted to, subsequent to the first operation of ash and soil mixing, in order to accelerate the growth of the germinated seedlings, moisture is conserved and plants are tided over spells of drought.

Rab regeneration as practiced in North Cuddapah.—The working plan of the division enjoins that in all felled coupes, the natural regeneration should be assisted by means of artificial regeneration by sowing seeds of valuable species on *rabs*. This work was started in 1929-30.

Seeds are collected free of cost by the staff in the months of February and March. A germination-percentage test is carried out by the Range Officer in April, to know whether the seeds collected by the beat staff are good or not. *Rabs* are reduced to ashes in the month of May. Directly after the burn (it takes 48 hours for the ashes to cool down) in order to prevent the ash from being blown away by wind or washed off by rain, soil and ash mixing is carried out. Sowing is done in the last week of May and completed at the latest by the third week of June. The method of sowing adopted until the last two years was broadcast. Experience showed that this method involved a

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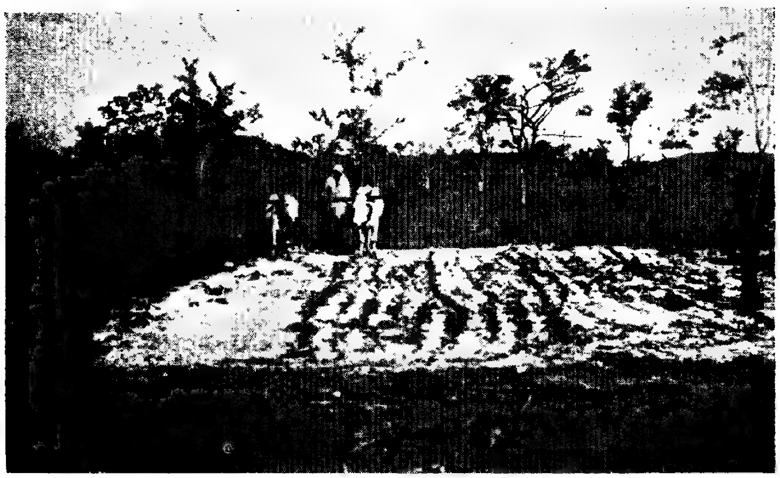


Ploughing a *rab* patch.

Spot Sowings.

S. Raghunatha Rao. *Rab Method in North Cuddapah.*

heavy wastage of seed and required ash and soil mixing over every inch of a *rab*. Besides, the germinated seedlings were either too crowded, thereby necessitating the removal of several of them to reduce congestion at the end of the first growing season, or there were so few seedlings on a *rab* and unevenly distributed, that a better and a cheaper method had to be evolved.

Experiments.—Experiments have been carried out in the last three years—

(1). to minimize the cost of *rab* sowing,

(2). to determine the optimum depth of ash,

(3). to discover the best method of arranging the slash piles for purposes of control and ready identification, and

(4). to find out the most suitable species.

(1). Soil and ash mixing over an entire *rab* of roughly a thousand square feet each, by means of *mammuties* or *dokudupara* (grass scraping implement) worked out to Rs. 0-4-0 to 0-6-0 per patch. The sub-soil being hard, it could not be turned up to a sufficient depth with either of these implements. The whole operation was found to involve a good deal of human energy and waste of time. Spot sowings with an espacement of 4′ × 4′ and each spot of 1′ × 1′ × 9″ dimension was found to have the advantage of spacing the seedlings and minimising the soil and ash mixing. In between these spots, line-sowings in pick-axed lines of 6″ depth were adopted to enable two species to be raised together—one of the valuable kind, such as red sanders and the other of the inferior kind like *Dolichandrone crispa* to keep the ground covered and keep down grass. This spot-*cum*-line method is an improvement over the broadcast method. It has resulted in great saving in seeds and in cost. The latest results have shown that the pick-axed line sowings, with lines two feet apart and seeds dibbled 6″ apart in the lines, gives the best results at the cheapest cost which is half of that for the broadcast method, or in other words, Rs. 0-3-0 per *rab* of a thousand square feet. The spot method is desirable only in places where the soil is good and in which red sanders and such other valuable species are to be raised.

(2). From the following figures of average height of seedlings of *Albizzia lebbek*, *Pterocarpus marsupium*, *Acacia sundra* and *Cassia siamea*, sown broadcast in the above mentioned *rab* patches, at the end of the first growing season, it will be seen that it is sufficient to pile up *débris* while green to not more than four feet in height, but it should be well pressed down.

Patch No.	A. LEBBEK.		P. MARSUPIUM.		A. SUNDRA.		C. SIAMEA.	
	No. of seed-lings.	Average height.	No. of seed-lings.	Average height	No. of seed. lings.	Average height.	No. of seed-lings.	Average height.
1 ..	153	1′ 5″	63	1′ 2″	*148*	3′ 8″	36	1′ 4″
2 ..	132	1′ 5″	25	1′ 3″	129	1′ 9″	13	1′ 0″
3 ..	132	1′ 7″	58	1′ 5″	116	3′ 3″	9	1′ 2″
4 ..	93	1′ 4″	93	1′ 0″	97	3′ 1″	34	1′ 2″
5 ..	*153*	1′ 6″	99	**1′ 5″**	87	4′ 0″	31	1′ 4″
6 ..	152	**3′ 2″**	**67**	1′ 4″	133	**4′ 6″**	36	**3′ 9″**

Bold face figures show the highest average height growth.

Italics show the largest number of seedlings germinated per patch.

Selection of Species.—Of the species tried, the ones that are best suited for *rab* work for the plateau forests in the order of their excellence are :—

1. *Pterocarpus marsupium* and *santalinus.*
2. *Cassia siamea.*
3. *Dolichandrone crispa.*
4. *Albizzia odoratissima.*

It has been found that *Albizzia lebbek* gives almost 100 per cent germination but suffers badly from browsing by sambhur and cattle ; if the *rab* patches are fenced effectively it is capable of reaching 12 feet in height in one growing season. Red sanders needs a well-drained soil. *Dolichandrone crispa* is a good utility species to sow in mixture

with other species like *Pterocarpus santalinus*, *Pterocarpus marsupium* and *Hardwickia binata*: its immunity from browsing helps to keep animals away from the more valuable species. It comes up on even poor soils quite well. *Acacia sundra* is not exacting in the matter of soil and comes up well almost anywhere. *Cassia siamea* is an exotic and is found to grow well only on certain soils: where it can grow vigorously, it has the advantage over the other species of fast growth, and dense foliage which covers the ground quickly and keeps down grass, and of immunity from browsing by members of the deer family and cattle. The best species met with for *rab* work in dry districts is *Dolichandrone crispa* which belongs to the order Bignoneaceae. It is the easiest to raise from seed: it is perfectly immune from browsing by animals and the least exacting in regard to soil and moisture conditions. It attained a height of 24″ at the end of the first growing season in an area of very poor soil. At the end of two growing seasons it attained a height of eight feet. Trees of this species seed profusely every year, the seeds are very light and extremely easy of collection. The seed germinates a fortnight after sowing. The seedling has a long tap-root which develops in the first year of growth to nearly two feet. It withstands drought better than most species indigenous to these arid forests. It is much valued as material for huts and is capable of growing to a girth of 36″ and a height of 25′. It is also useful as fuel. It coppices well.

Possibilities and limitations of rab method.—Many factors influence success in *rab* work. Aspect, gradient, distance from the plain, all play their part: but the most important of all is the rainfall or rather the seasonal distribution of rainfall. The latter here depends entirely on the timely occurrence of the south-west monsoon.

The problem of soil protection in this dry district where the danger from fire is very great, makes *rab* regeneration with species like *Dolichandrone crispa* and *Cassia siamea* which are capable of keeping down grass and immune to browsing by animals, of growing importance. It might be argued that the burning of *débris* kills small stumps which would otherwise form a valuable "accessory coppice" and destroys the existing young regeneration and seeds on the surface

of the soil. Against this, introduction on the *rab* of species more valuable than those indigenous to the locality or faster growing and with denser foliage would seem desirable. Artificial regeneration is difficult on poor soils such as are commonly met with in these forests without the initial help of some manure. The resultant ash of *rab* forms a valuable manure if properly mixed with the soil.

Rab as a measure of Fire Protection.—The burning of the *débris* sterilizes the soil, kills outright the grass and does not allow it to come up for at least two complete years, in fact I have known *rabs* which were free from grass even after the third year. Having got the grass destroyed, the resultant ash from a *rab* might just as well be put to another useful purpose, namely for raising a live belt of seedlings which would keep down grass from the fourth year onwards. *D. crispa* is a species which should prove successful for this work. There is, however, this drawback in clothing the proposed fire lines with tree-growth, namely that when the plants shed their leaves in summer, the layer of dry leaves might spread an accidental outside fire into the grass in the coupe. It is possible to prevent it by sweeping away the litter in the fire season, for three years from the third to the sixth year of a coupe and thereafter no special measures of fire protection would seem necessary.

Débris left lying about in a felled coupe would form a source of danger from fire, fungoid diseases and insect attacks to standing growth—either coppice or otherwise. Heaping of the slash and reducing it to ash is good from this point of view. Whether the slash piles should be in long lines or in small heaps of not more than 15 feet in diameter and evenly distributed over the coupe, is a matter that will have to be decided on the local conditions.

Need for Rapid Growth.—To return to and resow failed patches is not practicable; therefore it is of the utmost importance to get the plants to grow several feet in the first year, so that they are beyond the reach of their enemies (grass and animals) in the second year. Soil-working and soil-aeration between the south-west and the north-east monsoons, *i.e.*, in August-September, accelerates the rate of

growth of the plants, conserves moisture and tides them over a period of drought.

Expense of work.—When soil is deficient, on stony ground, on steep slopes, etc., *rab* work will not give good results, so it is better to avoid such places. *Rabs* generally amount to but a percentage of the area of the felled coupe, so that a cost of Re. 0-4-0 per patch may work out to Rs. 20-0-0 or more per acre of actually regenerated area. It is a moot point whether the money spent is worth the crop raised. Nevertheless, the fact that *débris* in a coupe is satisfactorily disposed of by burning and that without expense to government (it is incumbent on a coupe lessee to dump the slash), has the merit of reducing fire, fungal and insect attacks to standing growth. Coupe lessees consider *débris* heaping somewhat of a burden. Now that it has become known that *rab* regeneration can be made a success, it should be possible to get the piling of slash done hereafter by departmental agency at the rate of Re. 1/- per acre with a minimum *rab* of 2,000 square feet.

Ploughing is too expensive; pick-axing lines two feet apart and six inches deep is the cheapest and best method evolved. The stones found on the *rab* should be arranged on the lower side of the line to prevent the seeds being dislodged and hold up surface soil and conserve moisture. This has a marked effect on the health condition and rate of growth of the germinated seedlings.

Conclusions.—Selection of species suitable for each division with varying degrees of rainfall and temperature is of the greatest importance as on it the entire success or otherwise of *rab* work depends. One or more species found to suit a district as a result of experiments done here may not be equally good elsewhere. The immediate need in all divisions where *rab* work is attempted is to find out the species most suited to each district. Experience so far gained has proved that with proper supervision, timely completion of all the operations connected with the *rab* work, and above all seasonal rains, the money spent on artificial regeneration will not be a waste.

TEN LITTLE FOREST GUARDS.

BY TARZAN.

Ten little forest guards on a fire line,
One tried to run away and then there were nine.

Nine little forest guards earned the Ranger's hate,
One forgot the gift of ghee and then there were eight.

Eight little forest guards playing with some resin,
One was thrown into the drum and then there were seven.

Seven little forest guards picking off the ticks,
One picked himself to bits and then there were six.

Six little forest guards only just alive.
One missed the D. F. O. and then there were five.

Five little forest guards met a crusty boar,
One longed for ham and eggs and then there were four.

Four little forest guards cutting up a tree,
One swiped his Brahmin pal and then there were three.

Three little forest guards not knowing what to do,
One went up to Cambridge and then there were two.

Two little forest guards bathing in a lake.
One forgot he couldn't swim and then there was ek.

One little forest guard, daunted ? no, not he.
Being just a failed B. A. he lived to be I. G.

THE INDIAN SPECIES OF XYLOCARPUS.

By C. E. Parkinson, Forest Botanist, Forest Research Institute, Dehra Dun.

The name *Carapa* is probably better known to forest officers in India and Burma than *Xylocarpus*, but the latter should now be used

for the littoral tropical Indo-Malayan and East African genus hitherto generally known by the name *Carapa* which belongs to a distinct genus of West Indian and West African plants. The differences between these two genera are discussed by Harms in Engler's *Pflanzenfamilien iii* (1897), pp. 276—280.

I have for several years known of the existence of three species of *Xylocarpus* in the littoral and mangrove forests of Burma and the Andamans. They are described in the Forest Flora of the Andaman Islands (1923) in the genus *Carapa*. The three species are easily distinguished from one another in the field but two of them, *X. granatum* and *X. gangeticus*, with blunt rounded leaf apices, are difficult to distinguish in the herbarium where their large fruits are usually not represented and characters of bark and habit frequently not recorded.

A great deal of confusion has arisen in the synonymy of the two older species, *X. granatum* Koenig and *X. moluccensis* Roem., owing to difference of opinion in the interpretation of the two Rumphian plants on which they are more or less based and of Koenig's plant and the treatment of the two species as one in the *Flora of British India*.

Rumphius's *Martahul latifolia* and *Martahul parvifolia* are best understood by comparing the determining features of the two plants, the shape of the leaflets and size of the fruits.

Martahul latifolia is described as having leaves like those of *Metrosideros* (*Afzelia bijuga*) but with the apices more acuminate, 2—3 pairs of leaflets and a fruit like that of a pomegranate. It can be safely assumed that this is *X. moluccensis* Roem. which has a fruit about the size of a pomegranate, leaves that compare well with those of *Afzelia* except for their blunt or rounded apices and is the only one of the three species with pointed leaflets.

Martahul parvifolia is said to have two pairs, sometimes only one pair, of leaflets smaller than those of the former, with rounded apices, resembling the leaves of *Mangium fruticans* (*Aegiceras*) and a fruit as large as a man's head. This can only be *X. granatum* Koenig for the large fruit distinguishes that species and its well-rounded leaflets compare remarkably well with the leaves of *Aegiceras*.

Leaflets obovate to elliptic-oblong with blunt or well-rounded apices (type shown in Plate 15).

Leaflets obovate or obovate-oblong. Fruit attaining 7-10 inches in diameter. Stem with smooth pale bark, with much-branched ribbon buttresses spreading over the surface of the ground............... **1. X. granatum.**

Leaflets elliptic-oblong. Fruit 3-5 inches in diameter. Stem rough and fissured, dark-coloured; roots sending up erect pointed pneumatophores..... **2. X. gangeticus.**

Leaflets ovate or broadly so with pointed apexes (typeshown in plate 2)................................. **3. X. moluccensis**

1. Xylocarpus granatum Koenig in Naturf. (1784) 20, 2.

X. obovatus Juss. Mem. Mus. Par. 19 (1830) 244; Gamble in Flora Madr. Pres. (1915) 185, excl. synon.

Carapa obovata Blume Bijdr. (1825) 179; Prain in Rec. Bot. Sur. Ind. *ii* (1903) 293: Brandis, Ind. Trees (1906) 141, t. 66; Kurz For. Fl. Brit. Burma i (1877) 226: Parkinson, For Fl. Andam. Islds. (1923) 118; Watson in Malayan Forest Records No. 6 (1928) 70 and 75, tt. 36 and 37.

Carapa moluccensis Trimen, Hand. Fl. Ceylon i (1893) 251, non-Lamk.

Monosoma littorata Griff. Notul. iv (1854) 502.

Granatum litoreum, Martahul parvifolium Rumph. Herb. Amboin. 3 (1750) 92, t. 61.

A tree attaining 25 to 40 feet in height, stem usually crooked and often with knotty excrescences, bark thin and smooth, whitish to pale grey or light brown, peeling in thin irregular flakes which show green or pink beneath, base of the stem with thin ribbon buttresses much branched and spreading over the surface of the ground. Leaves usually with two pairs of leaflets, sometimes with only one pair, obovate or obovate-oblong with narrowed base and rounded apex. Fruit attaining 7-10 inches in diameter, rather smooth and brownish and splitting tardily by four valves.

Seashore of the Bay of Bengal among mangroves in tidal swamps.

I have seen the following specimens :—

Burma. *Herb. Dehra.* Bassein division Bawmi chaung, A. Long 10321, vern. *pinle ôn,* "tree with ribbon roots." *Herb. Maymyo.* Arakan. near Sandoway, C. E. Parkinson 8824 and 8889, vern, *pinle-ôn*. *Herb. Calc.*, Forest Department. Tenasserim Circle. 197. vern. *pinle-ôn*.

Bengal. *Herb. Dehra.* Sunderbans. R. C. Bhattacharya 14, vern. *Dhondul*.

Madras Presdy. *Herb. Dehra,* East Godaveri district, R. B. Cornwell 13.

Andaman Islands. *Herb. Dehra,* South Andaman, C. E. Parkinson 260, vern. *Pinle-ôn* ; Middle Andaman, C. E. Parkinson 55 and 1212. *Herb. Calc.*, Manpur, King's collector, 3 December 1892 ; Hobdaypur, Dr. King, 4 July 1891 ; Little Andaman, D. Prain March 1891 ; Strait Island, Prain's collector 15.

This is easily distinguished from *X. moluccensis* by its blunt not pointed leaflets, and from *X. gangeticus* by its smooth bark and thin spreading surface roots and from both these species by its larger fruit. It has the largest fruit of the three species described here.

There can be little doubt that this is Koenig's *X. granatum* and Rumphius's *Martahul parvifolium* to which Koenig referred his plant. The descriptions of both these writers obviously refer to the same plant—the one with blunt or rounded leaflets and fruits as large as a man's head or cocoanut—and this is the only species of the three dealt with here that fits such a description. Koenig's type localities are South India, Tranquebar (from where I have endeavoured to obtain specimens but unfortunately with no success), Ceylon and the Tenasserim coast. Trimen refers the Ceylon plant to Koenig's species and his description agrees on the whole with Koenig's : in describing it under the name *X. moluccensis* he is no doubt only following the *Flora of British India*.

In Burma and in the Andamans this is the most common of the three species and is well-known by the Burmese name *pinle-ôn* (sea

cocoanut) referring to the large conspicuous fruit which has been likened by various writers to a man's head, a cocoanut and a canon-ball. The wood is of good quality but the stems of the larger trees are usually hollow.

This is *Carapa obovata* of Troup's *Silviculture of Indian Trees*, i, p. 187.

2. **Xylocarpus gangeticus** C. E. Parkinson sp. nov.; affinis *X. granato* Koenig a quo fructibus minoribus et habitu facile distinguitur; a *X. moluccense* Lamk. foliolis elliptico-oblongis nec ovatis, apice obtusis neque acutis differt.

Carapa moluccensis var. gangetica Prain in Rec. Bot. Sur. Ind. ii (1903) 292.

Carapa moluccensis Watson in Malayan Forest Records No. 6 (1928) 70 and 75, tt. 34 and 35, non Lamk.

Carapa sp. No. 116, Parkinson in For. Fl. Andam. Islds. (1923) 118.

A tree with a straight stem, attaining a height of 40 feet or more, bark dark coloured rough and with longitudinal fissures, exfoliating in oblong flakes, buttresses small, roots sending up erected pointed pneumatophores through the soft tidal mud. Leaves usually with two pairs of leaflets resembling those of *X. granatum* but elliptic-oblong and rather larger. Flowers as in *X. granatum*. Fruit 3-4 inches in diameter, obscurely 4-lobed, reddish brown when ripe.

Seashore of the Bay of Bengal from the Sunderbans to Malaya and the Andaman Islands in tidal swamps with mangroves.

I have seen the following specimens:

Burma. *Herb. Dehra*, Irrawaddy delta, Pyapon, Meinmahla Reserve, C. G. Rogers 39; Myaungmya, Kalayeik Reserve, J. H. Lace 2947. Arakan, Gwa chaung near Sandoway, C. E. Parkinson 8832 and 8856, vern. *kyatnan*. Tenasserim. Puttaw island near Mergui, C. G. Rogers 414, vern. *kyatnan*; Tenasserim river, Mayinnge, C. E. Parkinson 2011 vern. *kyatnan*.

Bengal. *Herb. Dehra*, Sunderbans, S. C. Chaterji 27, vern. *pussur*.

Andaman Islands. *Herb. Dehra,* North Andaman, Stewart Sound, J. H. Lace 2842 ; Middle Andaman, Bomlungta, C. E. Parkinson 505, 1131 and 1188.

In herbarium specimens this closely resembles and may be easily confused with *X. granatum* but in the field it is easily distinguished by the characters of bark and buttresses already mentioned and the pneumatophores which sometimes extend up the base of the small buttresses. It also has a much smaller fruit, with fewer seeds, than that of *X. granatum* and is easily distinguished from *X. moluccensis* by the shape of the leaflets.

In the characters of buttresses and pneumatophores these two plants *X. granatum* and *X. gangeticus* are comparable with the littoral *Heritieras, H. littoralis* Dryand having thin branched surface ribbon buttresses like those of *X. granatum* but generally larger and *H. fomes* Buch. (*H. minor* Roxb.) having erect pointed pneumatophores like those of *X. gangeticus* but more numerous and longer.

Prain treated this as a variety of *Carapa moluccensis* Lamk. but it resembles *Carapa obovata* Bl. more closely in herbarium specimens. It is however deserving of the rank of species and has, in fact, already been treated as such by more than one writer but confused with *X. moluccensis.*

The plant described by Troup in the *Silviculture of Indian Trees* p. 186 is mainly *X. gangeticus*, especially the Sunderbans plant, but F. H. Todd's Andaman plant is most probably the true *X. moluccensis* Roem.

In the Sunderbans this is called *pussur* and in Burma it is well known by the name *kyatnan*. It is of some forest importance as it grows to a large size, often attaining 60 feet or more in height with a straight stem (see plate 15) and has timber of good quality.

Prain l. c. p. 292 has the characters of the bark of the two plants reversed in the key but they are correctly described in the descriptions which follow.

3. **Xylocarpus moluccensis** Roem. Syn. Hesper. (1846) 124.

Carapa moluccensis Lamk. Encycl. i (1785) 621 quoad descr. excl. Rumph. Herb. Amboin. 3 t. 61 : Hiern in Fl. Brit. Ind. i (1875) 567 pro parte ; Brandis, Indian Trees (1906) 141 : Kurz, For. Fl. Brit. Burma i (1877) 226 ; Parkinson, For. Fl. Andam. Islds. (1923) 118.

Granatum litoreum, Martahul latifolium Rumph. Herb. Amboin. 3 (1750) 92 t. 62.

A small tree attaining 15 to 30 feet, often crooked and frequently low branching; bark grey, rough with longitudinal fissures and peeling in flakes. Leaves with 2 or 3 pairs of leaflets, rarely with one pair, ovate, often broadly so, with rounded base and pointed apex. Fruit the size of an orange or smaller, obscurely 4-grooved.

Seashore of the Andaman Islands and Malaya. Usually along beaches and apparently favouring the open coast and not occurring in deltaic or tidal swamps.

I have seen the following specimens :—

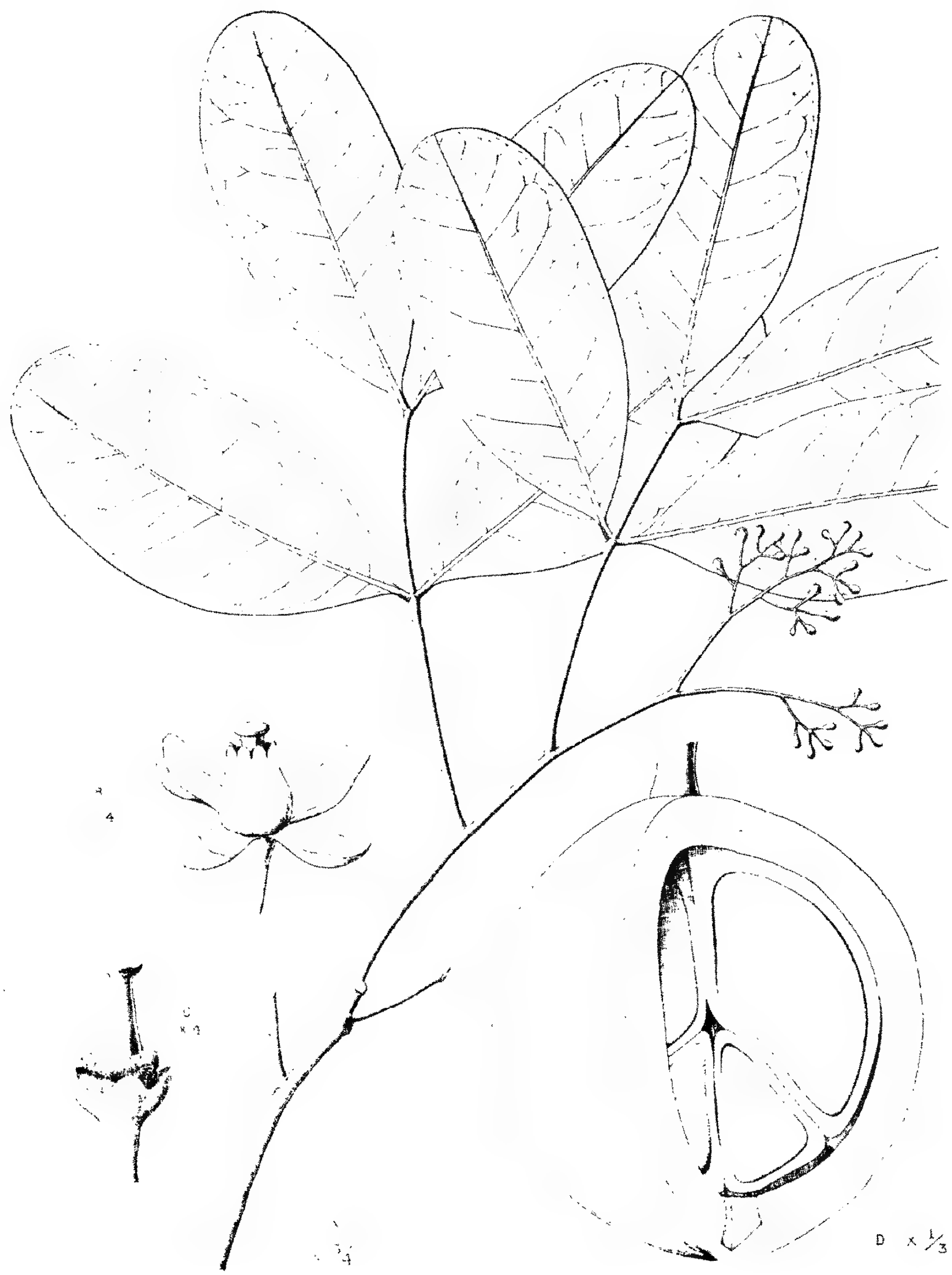
Andaman Islands. *Herb. Dehra* and *Herb. Calc.*, Rutland Island, C. E. Parkinson 863 and 876 ; Long Island, C. E. Parkinson 747 ; South Andaman, Port Mouat, S. Kurz ; Narcondam Island, C. G. Rogers, 3rd October 1904.

Nicobar Islands. *Herb. Dehra*, M. C. Bonington 209. *Herb. Calc.*, Kotehal, S. Kurz ; King's collector 528.

Malaya. *Herb. Calc.*, Griffith 1080 ; Kedah, Pulo Sinsong, C. Curtis, June 1890 ; Malacca, Stolikza, Herb. Sulp. Kurz ; Java, S. H. Koorders 4807b.

This is easily distinguished from the other two species by its broad ovate-pointed leaflets. It has a fruit somewhat similar to that of *X. gangeticus* but much smaller than that of *X. granatum*. In specimen C. E. P. 876 the leaflets of one flowering twig are almost cordate with pointed apices and are larger than is usual, measuring 6 inches long by 4 inches broad.

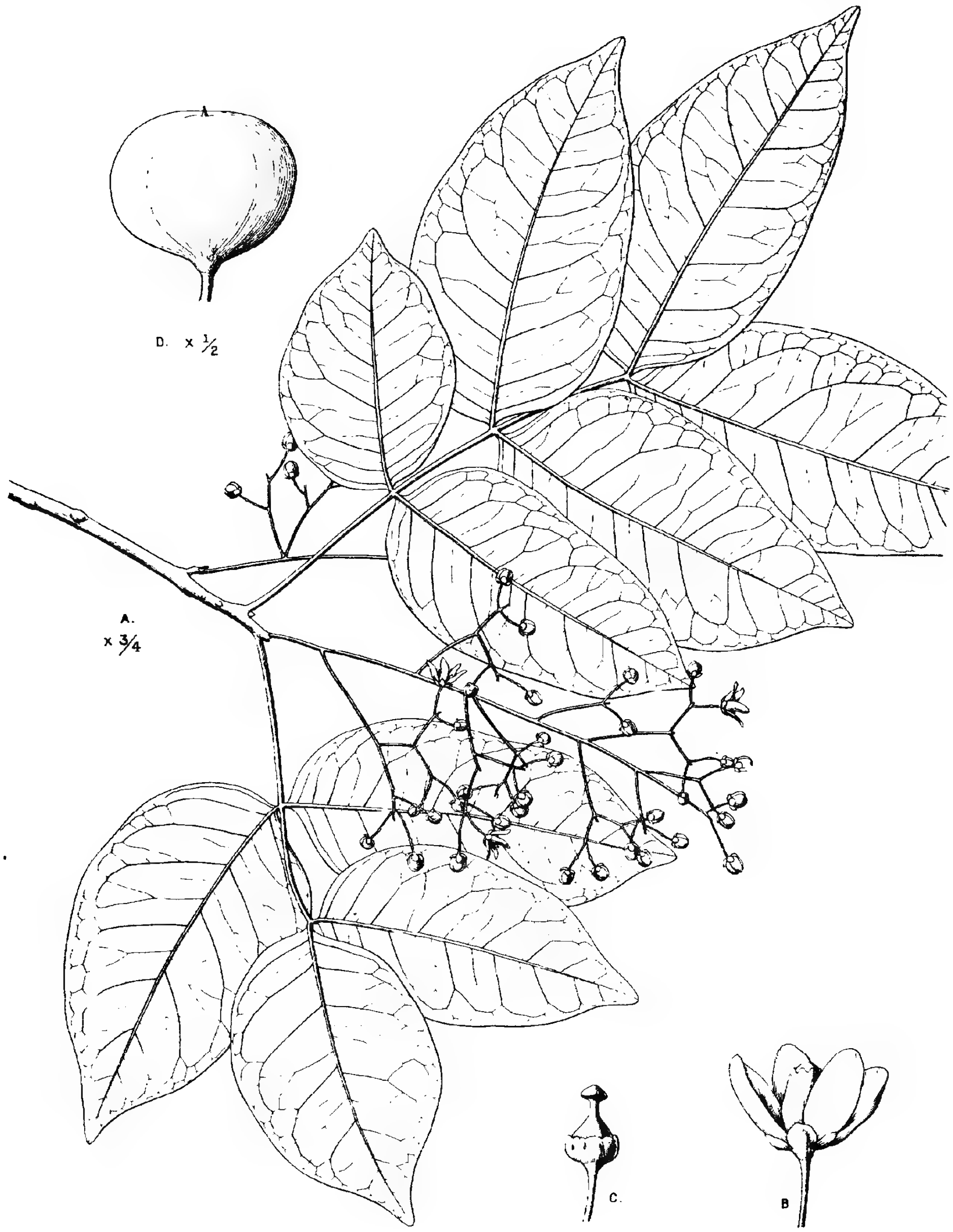
Plate 15.



[illegible] Sir [illegible] del.

[illegible] Koenig.

Plate 16.



Ganga Singh, del.

XYLOCARPUS MOLUCCENSIS Roem.

Photo W. A. Robertson. Xylocarpus gangeticus, C. E. Parkinson.

It is clear that this is not Koenig's plant as it does not agree with his description of the leaves and fruit of *X. granatum*. It is the only plant of the three species dealt with here that fits Lamarck's description of the leaves of *Carapa moluccensis* "foliolis subtrijugis, ovato acutis." Lamarck also mentions that it grows in sandy and rocky situations whereas the other two species grow in mangroves. His reference, however, to Herb. Amboin. 3 t. 61 is incorrect.

King in *Materials for a Flora of the Malayan Peninsula* (1895) p. 87, and, following him, Ridley in the *Flora of the Malayan Peninsula* i (1922) 414 have confused the leaves and fruits of two species. Under the name *Carapa obovata* they have described the leaves of *Xylocarpus granatum* with the fruits of *X. moluccensis* and under *C. moluccensis* the leaves of *X. moluccensis* with the fruits of *X. granatum*.

Kurz says that the flowers of this species are 5-merous but in all the three species dealt with here they are usually 4-merous and only occasionally 5-merous.

Explanation of the plates.

Plate 17. *Xylocarpus gangeticus* C. E. Parkinson, photograph by W. A. Robertson taken at Bomlungta, Middle Andaman.

Plate 15. *Xylocarpus granatum* Koenig. A, flowering twig, × $\frac{3}{4}$. B, open flower, about × 4. C, flower with petals and staminal tube removed, about × 4. D, fruit with one valve removed showing seeds, about one-third actual size (from a sketch made in the field at Bawmi, Arakan coast).

Plate 16. *Xylocarpus moluccensis* Roem. A, flowering twig, × $\frac{3}{4}$. B, flower, about × 3. C, flower with perianth and staminal tube removed, about × 3. D, young fruit about half actual size.

THE LIMITATIONS OF FOREST RECONNAISSANCE SURVEYS.

BY J. G. WATSON, CONSERVATOR OF FORESTS, RESEARCH, F. M. S. & S. S.

Though the campaign for the better utilization of Empire timber resources has given a much needed fillip to forest departments generally, and more particularly to those in the tropics, it is also helping to dispel the popular illusion that the only real barrier to a roaring export trade is the conservatism and general stickiness of the forest authorities concerned. People are beginning to realise that there are forests and forests: that every well-wooded slope that can be seen from the deck of a liner passing along a tropical coast is not necessarily richly stocked with first class woods that only need to be cut to slide gently by gravity into the lowlands: that timbers that attract the local market may be of no account whatever at home, and *vice versa*; that local utilization is not entirely haphazard, nor are the methods of the native loggers and sawmillers nearly as irrational as they appear at first sight to western eyes: that there are such things as borers, heart rot, surface checks, warping, splitting, sapwood, surface stain, and a variety of defects, some corrigible and some not; in short, that the manufacture of timber for export is an exceedingly intricate business.

Another illusion that it is necessary to dispel, is that an adequate estimate of the general productivity of tropical rain forest areas can be based on large-scale reconnaissance surveys. The view seems to be rather widely held that the inability of tropical colonies to take full advantage of the preferential tariffs is chiefly due to their ignorance with regard to supplies, and that the obvious way to counteract this is to undertake extensive enumeration surveys of their forest resources. This superficially attractive doctrine is a dangerous one, and as we in Malaya have probably done more in this direction than have any of the other colonies or dependencies where tropical rain forests occur, we are in a position to speak with some authority on the limitations of this form of forest valuation.

A description by the late Forest Research Officer F. M. S., Dr. F. W. Foxworthy, of the methods employed in Malaya, will be found on page 78 of Volume III (1924) of the *Empire Forestry Journal.* It is beyond doubt that the work that has been done on these lines has proved extremely valuable in giving a general indication of the distribution of the more important species that occur in our forests, and has provided us with rough average figures for the number of trees and cubic feet of timber of *sawable size* per acre. Within very wide limits—though sufficiently narrow for this particular purpose—we have been able to locate the richest timber areas and to demand their reservation when they were in danger of disforestation, and to some extent the enumerations have been of assistance in the compilation of silvicultural working schemes. Such surveys have also been of considerable educational value in the training of newly-joined officers and subordinates who are attached to the field parties. But as a guide to the merchantable value of the forests, they are of very limited value. From the point of view of the potential saw-millers their sole use might be to serve as a very rough guide to the more richly stocked places in which it would be worth while to carry out more intensive cruises. Further than that it would be extremely unwise to rely on them.

In the article mentioned above the following statement occurs:—"The next step in the development of our knowledge is quantitative studies which will give us an understanding of the gross values of our forests *and of the revenue which they can be made to yield.*" The italics are mine. Although we must all agree that the objective is entirely laudable, few of us would care to base any revenue estimate on the figures provided by enumeration surveys of the type described. It would be simple enough to make a rough calculation of the royalty value of the timber that would be merchantable if transport conditions were favourable and the market insatiable,—though even this might easily be upset by the subsequent discovery that half the trees were hollow or otherwise defective,—but to attempt this in total ignorance of the hundred and one other factors of uncertainty that can make or mar a logging venture would be too much in the nature of a gamble.

The total area examined to date by the enumeration strip method in Malaya amounts to about a million acres. The intensity of valuation has varied between 0·5 per cent and 10 per cent involving complete enumeration on a strip one chain wide and approximately 1,250 miles long. The cost of the work cannot be stated with any accuracy, nor would it be fair to judge it on actuals, since many of the surveys have been debited with the transport allowances and expenses of officers who were attached to the field parties for training purposes. Some idea of the legitimate cost can, however, be obtained from the figures that were recently compiled when the formation of a permanent reconnaissance party was under consideration. These showed that the cost of a 10 per cent survey would vary from about 8d. to 10d. per acre according to the degree of supervision exercised by the officer in charge. Taking an average figure of 9d. the cost of enumerating a block of 10,000 acres would thus be £375 for a 10 per cent valuation, and probably in the neighbourhood of £60 for a one per cent valuation, the proportionately higher cost of the latter being due to the relatively greater frequency of moving camp, and to the transport costs to and from the area being identical in both cases.

Opportunity was taken at the same time to compare the total number of stems and relative abundance of the various constituents of the forest based on the figures from all, one half, and one tenth of the lines cut in a 10 per cent enumeration of about 9,500 acres of fairly difficult hilly forest, these corresponding to valuations of ten per cent, five per cent and one per cent respectively. The differences between the two higher percentages were insignificant, both in the relative abundance of the species and the total number of trees per acre. The one per cent valuation showed differences in the order of abundance of the species, but was in close agreement as regards the total number of trees. For ordinary purposes, that is for the determination of the *relative* value of the forest examined, it was as effective as the other two.

In the example cited above the volumes were omitted, as the labour of calculation would have been immense. As a matter of fact, the determination of volume has nowadays given way to the record-

ing of diameter classes only, the reason being that the old Bornean tables (see Dr. Foxworthy's article previously mentioned) are not sufficiently accurate to furnish reliable data, though they served a useful purpose in the earlier enumerations by giving us a rough idea of how we stood by comparison with forests elsewhere. But as a guide to the actual volume represented by the individual species they are quite unreliable, and as we were gradually becoming convinced of the hopelessness of trying to assess the merchantability of our forests by surveys of this character, we considered it more desirable to collect information in a form that would be of greater silvicultural and botanical value. Instead, therefore, of attempting to work out the volumes of species or groups of species by very doubtfully accurate methods, the tendency has been to increase the number of species under observation and to pay greater attention to the distribution of the size classes. It would, however, still be possible to work out the volumes from the data collected, if at any time such a course appeared desirable.

The latest enumeration, undertaken by Mr. D. B. Arnot with the assistance of the Forest Botanist, the students at the vernacular school, and two European officers attached for instructional purposes records the distribution of 140 species in two inch diameter classes between 12 and 40 inches. There are in addition three upper classes, *viz.*, 40 to 48, 48 to 60, and over 60 inches, and a bottom class of 4 to 12 inches for trees in the pole stage. The number of trees of each species and diameter class has been computed for each 10 chains (*i e.*, each acre) of enumeration strip. There is thus a very complete record not only of the distribution of all but the most obscure species, but also of the diameter classes in each case. With the aid of the topographical map that existed for the area under examination, the abundance of the more valuable species above and below the 1,000 foot contour was worked out and the fact established that within the altitudinal limits of the area examined (maximum 2,400 feet) the quality of the forest is generally better on the higher ground. The report contains notes on the distribution and growth of the more important species and does not confine itself (as former reports did) to the groups of

species included in the *timber roll* (royalty rate list) with the rest lumped under "miscellaneous." Considerable attention was paid to the topography of the area with an eye to possible lines of extraction, and a rough estimate was made of the royalty value of the dipterocarp timber of merchantable size. The length of the strips examined was 2,130 chains (213 acres) giving a percentage of 8·9 for the whole block of 2,400 acres.

This survey forms an unusually complete record of the forest that it covers, and would undoubtedly provide very valuable information for use in any projected exploitation scheme. But it differs from the earlier surveys in that it was carried out in full knowledge of the generally high quality of the forest. It was not a reconnaissance for the purpose of discovering valuable forest, but rather a cruise of an area known to be above the average. It was, of course, comparatively expensive, occupying the full time of three European officers and a large number of subordinates for 10 days, but this was chiefly due to the fact that it was undertaken for instructional purposes. But even if it had been done on strictly economic 1 lines it would have necessitated the constant supervision of a senior officer and precisely the same degree of attention from the Forest Botanist. It is probable that the field work would have taken twice as long in the absence of the attached officers, whilst the main burden of compiling the results would have fallen on the office staff.

One of the main points of difference that requires to be stressed is the closing of the count at 10-chain intervals. In the earlier reconnaissances there were no such units, the figures being averaged for the entire area. They did not, therefore, furnish any indication of the location of the richer patches of forest or enable them to be considered in connection with topographical features or lines of transport. To carry out extensive cruising on such lines would necessitate a far larger staff and greater expenditure than most forest departments could reasonably be expected to carry. It is believed, nevertheless, that the degree of accuracy is the minimum that is necessary to serve as a basis for the calculation of the potential output of merchantable timber, and that the expenditure on such a

survey would be fully justified only if the way were clear in other directions.

As far as Malaya is concerned, timber export difficulties are not due to lack of knowledge of the available resources, but to the low prices offered for utility timbers of the class we have to sell, coupled with high ocean freights. It is not a question of competing with bulk supplies of softwoods. That is a field in which we cannot hope to be interested for a very long time to come, if ever. Our natural forests are of the mixed evergreen type carrying yields of forty to fifty tons of timber of millable size per acre, of which only a fraction can be marketed. The home market is interested only in some of the softer dipterocarps (the heavy-constructional sorts are of more value locally) and imposes extraordinarily strict grading rules. Though our methods of extraction and conversion may be primitive, they have shown themselves to be capable of supplying what is wanted. But the saw-millers are people of limited capital; they have difficulty in financing the carrying of large stocks through the period required for seasoning, and unless the margin of profit is greater than that to be obtained in the local market (which is very tolerant with regard to grading, and pays on the nail for unseasoned wood) they cannot be expected to show much enthusiasm for the export trade.

That then is the position in Malaya. We may fairly claim to have made the fullest possible use of extensive reconnaissance surveys by the strip enumeration system, and to have demonstrated that an intensity of 1 per cent is sufficiently accurate for the purpose of deciding on the best areas for reservation. We consider that the data from such reconnaissance surveys cannot be used with any safety for calculating the probable yield from any area, and that nothing short of an intensive enumeration with concurrent mill studies can provide a reliable indication of the potential output of marketable species. We are convinced that the local industry is technically capable (under adequate supervision) of supplying various classes of timber in which the home market is interested, if the economic difficulties, mainly arising from high transport costs, can be overcome. And finally, we are satisfied that the species producing the timbers that

are in demand are capable of being grown by established methods of regeneration on a scale that will ensure not only continuance of but ultimately a large increase in supplies.

SEED CROP AND FERTILITY OF ANOGEISSUS LATIFOLIA

SEED CROP AND FERTILITY OF ANOGEISSUS LATIFOLIA

By H. G. Champion, M.A., Silviculturist, F.R.I.

On page 541 of Volume II of Troup's *Silviculture of Indian Trees*, the following words appear :—" The want of fertility of the seed does not accord with the fact that reproduction often springs up in dense masses on well-drained hillsides and Mr. R. S. Pearson has advanced a theory (*Indian Forester* 1907, p. 231) to explain this fact. Having noticed in the Panch Mahals that reproduction appeared in even-aged masses differing from each other by definite intervals of years, as determined by counting rings on cut seedlings and saplings, he ascertained that the years in which reproduction took place were those following on years of deficient rainfall. He surmised, therefore, that whereas under normal conditions the tree produces little or no fertile seed, the production of fertile seed is stimulated by years of drought. This theory is well worth following up by fertility tests of seeds carried out annually for a series of years, including seasons of good and of deficient rainfall, the results so obtained being supplemented by comparative observations of the state of reproduction in the forest."

Some trees were accordingly marked down on the hill slopes above Thano, Dehra Dun division, in 1926, with a view to collecting and testing the seed annually over a period of years. A fatal tragedy marked the commencement of the investigation, for the seed collector, a valued and trusted subordinate by name Nain Singh, whilst alone collecting the seed, fell down from a tree and was found dead a day later when his absence was noticed.

A new set of four trees was selected in 1928 in a more convenient situation at Mohand in Saharanpur division and has been kept under observation for the past six years. A sample of the seed (aiming at about 2 lbs.) has been collected separately from each tree as soon as fully ripe at the end of April or early in May, and an estimate made of the quantity remaining on the tree. The seed was extracted and cleaned and a sample quarter of an ounce weighed out and the seed number counted. Four or five samples, each of 2 oz., were weighed out for the germination tests which were made in shallow wooden

boxes in a light medium of mixed sand, leaf mould and garden soil, all conditions being kept as similar as possible every year. The germination tests were all made at the end of May soon after collection, except in 1928 when they were done at the break of the rains, and in 1932 and 1933 when they were repeated at both seasons, the July results being 33 per cent lower than the May figures. Figures thus increased are included in the table.

There are about 3,500 seed to the ounce and so 7,000 per test and the number of seedlings obtained varied from 54 to *nil*. The seedlings are very liable to insect damage particularly by grasshoppers and crickets, necessitating frequent inspections. Germination is fairly quick commencing after five or six days and is virtually completed in two weeks, the seed either germinating right away or rotting. It is evident from a scrutiny of the records and from the nature of the work, that it is quite impossible to claim that the tests are strictly comparable from year to year, the care taken to that end notwithstanding; but such as they are, they appear worth recording, and the essential data are given in the appended tabular statement.

Now the driest year in the period covered was 1931 with only 60″ rainfall as compared with the average of 81″ and on Pearson's suggestion, 1932 should have been a good year for reproduction. Actually precisely the opposite occurred, for the total seed crop was by far the smallest recorded, being estimated at only $4\frac{1}{2}$ lbs. as compared with the average of 13 lbs., and the germination per ounce was as low as five compared with the average of nine; two trees produced no seed at all. On the other hand, it will be noticed that the best results were obtained in seasons after years of good rainfall, *i.e.*, in 1930 and 1933, though 1928, following the exceptionally heavy rain (99·7″) of 1927, did not show good germination. The actual seed crop was best and much the same (22 lbs.) per tree in 1929, 1930 and 1933, and as noted, by far the worst in 1932.

There would appear to be some variation between the four trees in the weight and fertility of the seed produced, tree No. 4 producing an appreciably lighter seed with the best germinative capacity.

It would thus appear that the tests described have not borne out the suggestion that a drought year is followed by a good seed year for this species in North India, but it has not been possible to carry out the supplementary comparative observations of the state of reproduction in the forest as proposed by Troup.

Seeding of Anogeissus

Date of collection.	Tree No.	Total seed crop estimated weight. Lb.	Oz.	Seed weight per ounce.	Date of test.
1	2	3	4	5	6
1928	1	8	2	2,750	23-7-28.
	2	6	8	3,540	,,
	3	6	3	2,410	,,
	4	..	13	3,480	,,
Total ..	..	21	10	12,180	
	Average	5	6·5	3.045	
	133%				
1929	1	44	1	3,250	11-5-29
	2	1	11	3.240	,,
	3	22	8	2,480	,,
	4	16	14	4.050	,,
Total ..	..	85	2	13.020	
	Average	21	4·5	3,255	
1930	1	48	..	3.090	7 5 30
	2	17	8	3,090	,,
	3	20	..	4.580	,,
	4	4	8	3,510	,,
Total ..	..	90	..	14,270	
	Average	22	8	3,568	
1931	1	6	8	3,540	30-5-31
	2	..	..	..	,,
	3	6	8	3,340	,,
	4	4	6	3,930	,,
Total ..	..	17	6	10,810	
	Average	5	12·7	3,603	
28-4-1932	1	4	6	4,250	20-5-32
	2	..	..	..	..
	3	0	5	3,380	30-5-32
	4	..	..	..	..
Total ..	..	4	11	7,630	
	Average	2	5·5	3,815	
28-4-1932	1	4	6		5-7-32
	133%.				
27-4-1933	1	45	12	3,850	25-5-33
	2	7	13	3,580	,,
	3	13	11	3,650	,,
	4	24	7	4,420	,,
Total ..	..	91	11	15,500	
	Average	22	14·8	3,875	
6-7-1933	1	..	..	..	6-7-33
	2	..	..	..	,,
	3	..	..	..	,,
	4	..	..	..	..
Total ..	..	..	..	..	
	Average				
	133%				
	1	156	13	20,730	*Total and*
	Average	**26**	**2**	**3.455**	
1928-33	2	33	8	13,450	
	Average	**5**	**9**	**3,363**	
	3	69	3	19,840	
	Average	**11**	**9**	**3,307**	
	4	51	0	19,390	
	Average	**8**	**8**	**3.878**	
			Grand total	*for all trees*	
GRAND TOTAL ..	..	310	8	73,410	
	Average	**13**	..	**3,496**	

latifolia.

Weight of seed per test.	Actual number germinating *(Rejected tests).	Average germination per ounce.	Average germination per 10,000 seed.	Seedlings from whole crop.	Rainfall of previous year for Dehra Dun.
7	8	9	10	11	12
3 oz.	8, 6, 13, 7	2·8	10·3	364	99·71
,,	2, 1, 6, 5	1·2	3·3	125	
,,	14, 7, 4, 11	3·0	12·5	297	
2 & 3 oz.	9, 10, 35, 27	8·1	22·6	105	
		15·1	48·7		
		3·8	12·2		
		(5·1)	(16·3)		
2 oz.	7, 7, 8, 11	4·1	12·7	2,891	70·79
,,	3*, 10, 9, 7	4·3	13·4	116	
,,	6, 9, 2*, 17*	3·8	15·1	1,368	
,,	2*, 6, 7, 10	3·8	9·5	1,026	
		16·0	50·7		
		4·0	12·7		
2 oz.	29, 30, 32, 38	16·1	52·2	12,365	85·63
,,	11, 23, 14, 25	9·1	29·6	2,548	
,,	42, 31 40, 35	18·5	40·4	5,920	
,,	27, 54, 27, 35	17·9	50·9	1,289	
		61·6	173·1		
		15·4	43·3		
2 oz.	9, 12, 8, 10	4·9	13·8	610	79·07
..	..	..	..	..	
2 oz.	24, 23, 20, 20	10·9	32·5	1,134	
,,	12, 27, 17, 19	9·4	23·9	658	
		25·2	70·2		
		8·4	23·4		
2 oz.	9, 1*, 8, 13, 6	4·5	10·6	315	60·16
..	..	..	..	..	
1·3 oz.	8	6·0	17·6	30	
..	..	..	..	..	
		10·5	28·2		
		5·25	14·1		
2 oz.	6, 9, 6, 3, 1*	3·0	7·1		
		(4·0)	(9·5)		
2 oz.	23, 31, 33, 28, 28	14·3	37·1	10,468	89·94
,,	26, 15, 17, 19, 23	10·0	27·9	1,250	
,,	34, 34, 29, 43, 41	18·1	49·6	3,964	
,,	48, 48, 44, 50, 53	24·3	54·9	9,501	
		66·7	169·5		
		16·7	42·4		
2 oz.	20, 12, 22, 27, 26	10·7	27·8		
,,	12, 10, 7, 10, 8	4·7	13·1		
,,	16, 25, 28, 17, 21	10·7	29·3		
,,	37, 38, 38, 43, 39	19·5	44·1		
		45·6	114·3		
		11·4	28·6		
		(15·2)	(38·1)		
average for each tree.		46·7	136·7		
		7·8	**22·8**	**3,260**	
		24·6	74·2		
		6·2	**18·6**	**552**	
		60·3	167·7		
		10·1	**28·0**	**1,869**	
		63·5	161·8		
		12·7	**32·4**	**1,727**	
		195·1	540·4	..	485·30
		9·3	**25·7**	..	80·9

INTERNATIONAL CONFERENCE FOR THE PROTECTION OF THE FAUNA AND FLORA OF AFRICA, LONDON, 1933.

BY D. STEWART, B.Sc., INDIAN FOREST SERVICE.

Observer for the Government of the United Provinces, India, at the Conference.

During the first week of November, 1933, the eyes of all those interested in the preservation of the fauna and flora not only of Africa, but of many other parts of the world, were focussed on this important international conference which was held in London. Though the conference dealt in particular with the continent of Africa, the governments concerned made it clear that they hoped ultimately that it would be possible to extend the results of the conference to other important parts of the world where the fauna and flora are in danger, in the conditions at present obtaining, of extinction or permanent injury.

The immediate purpose of the present conference was to conclude a convention to be agreed upon by all the powers having possessions in Africa, with a view to preserving adequately the natural fauna and flora of that great continent. I give below the words of the preamble to the convention agreed upon by the conference as they explain concisely the purpose of the conference and show that though Africa is particularly mentioned, other parts of the world are not excluded from the scope of the convention.

Convention relative to the Preservation of Fauna and Flora in their natural state.

The Governments of the Union of South Africa, Belgium, the United Kingdom of Great Britain and Northern Ireland, Egypt, Spain, France, Portugal and the Anglo-Egyptian Sudan, considering that the natural fauna and flora of certain parts of the world, and in particular of Africa, are in danger, in the present conditions, of extinction or permanent injury, desiring to institute a special regime for the preservation of fauna and flora.

Considering that such preservation can best be achieved (1) by the constitution of national parks, strict natural reserves and other reserves within which the hunting, killing or capturing of fauna, and the collection or destruction of flora shall be limited or prohibited, (2) by the institution of regulations concerning the hunting, killing and capturing of fauna outside such areas, (3) by the regulation of the traffic in trophies, and (4) by the prohibition of certain methods of and weapons for the hunting, killing and capturing of fauna, have decided to conclude a convention for these purposes and have agreed on the following provisions—(extracts from which are given below) :—

ARTICLE 2.

For the purposes of the present Convention—

1. The expression "national park" shall denote an area (*a*) placed under public control, the boundaries of which shall not be altered or any portion be capable of alienation except by the competent legislative authority, (*b*) set aside for the propagation, protection and preservation of wild animal life and wild vegetation, and for the preservation of objects of asthetic, geological, prehistoric, historical, archæological, or other scientific interest for the benefit, advantage, and enjoyment of the general public, (*c*) in which the hunting, killing or capturing of fauna and the destruction or collection of flora is prohibited except by or under the direction or control of the park authorities.

In accordance with the above provisions facilities shall, so far as possible, be given to the general public for observing the fauna and flora in national parks.

2. The term "strict natural reserve" shall denote an area placed under public control, throughout which any form of hunting or fishing, any undertakings connected with forestry, agriculture, or mining, any excavations or prospecting, drilling, levelling of the ground, or construction, any work involving the alteration of the configuration of the soil or the character of the vegetation, any act likely to harm or disturb the fauna or flora, and the introduction of any species of fauna and flora, whether indigenous or imported, wild

or domesticated, shall be strictly forbidden ; which it shall be forbidden to enter, traverse, or camp in without a special written permit from the competent authorities ; and in which scientific investigations may only be undertaken by permission of those authorities.

ARTICLE 4.

The Contracting Governments will give consideration in respect of each of their territories to the following administrative arrangements :—

1. The control of all white or native settlements in national parks with a view to ensuring that as little disturbance as possible is occasioned to the natural fauna and flora.

2. The establishment round the borders of national parks and strict natural reserves of intermediate zones within which the hunting, killing and capturing of animals may take place under the control of the authorities of the park or reserve ; but in which no person who becomes an owner, tenant, or occupier after a date to be determined by the authority of the territory concerned shall have any claim in respect of depredations caused by animals.

3. The choice in respect of all national parks of areas sufficient in extent to cover, so far as possible, the migrations of the fauna preserved therein.

ARTICLE 7.

Irrespective of any action which may be taken under article 3 of the present Convention, the Contracting Governments shall, as measures preliminary and supplementary to the establishment of national parks or strict natural reserves :—

1. Set aside in each of their territories suitable areas (to be known as reserves) within which the hunting, killing, or capturing of any part of the natural fauna (exclusive of fish) shall be prohibited save (*a*) by the permission, given for scientific or administrative purposes in exceptional cases by the authorities of the territory or by the central authorities under whom the reserves are placed, or (*b*) for the protection of life and property.

2. Extend in these areas, so far as may be practicable, a similar degree of protection to the natural flora.

3. Consider the possibility of establishing in each of their territories special reserves for the preservation of species of fauna and flora which it is desired to preserve, but which are not otherwise adequately protected, with special reference to the species mentioned in the annex to the present Convention.

4. Furnish information regarding the reserves established in accordance with the preceding paragraphs to the Government of the United Kingdom, which will communicate such information to all the Governments mentioned in article 5, paragraph 2.

5. Take, so far as in their power lies, all necessary measures to ensure in each of their territories a sufficient degree of forest country and the preservation of the best native indigenous forest species, and, without prejudice to the provisions of article 2, paragraph 2, give consideration to the desirability of preventing the introduction of exotic trees or plants into national parks or reserves.

6. Establish as close a degree of co-operation as possible between the competent authorities of their respective territories with the object of facilitating the solution of forestry problems in those territories.

7. Take the necessary measures to control and regulate so far as possible the practice of firing the bush on the borders of forests.

8. Encourage the domestication of wild animals susceptible of economic utilisation.

ARTICLE 10.

1. The use of motor vehicles or aircraft (including aircraft lighter than air) shall be prohibited in the territories of the Contracting Governments, both (i) for the purpose of hunting, killing, or capturing animals, and (ii) in such manner as to drive, stampede, or disturb them for any purpose whatsoever, including that of filming or photographing; provided, however, that nothing in the present paragraph shall affect the right of occupiers in respect of land occupied by them, or of Governments in respect of land utilised for public purposes, to use motor vehicles or aircraft for the purpose of driving away, capturing, or destroying animals found on such land in all cases where such ejection, capture, or destruction is not prohibited by any other provision of the present Convention.

2. The Contracting Governments shall prohibit in their territories the surrounding of animals by fires for hunting purposes. Wherever possible, the undermentioned methods of capturing or destroying animals shall also be generally prohibited :

(*a*) the use of poison, or explosives for killing fish ;

(*b*) the use of dazzling lights, flares, poison, or poisoned weapons for hunting animals ;

(*c*) the use of nets, pits or enclosures, gins, traps or snar s, or of set guns and missiles containing explosives for hunting animals.

* * * * *

The great importance which the various governments concerned with Africa attached to the conference is clearly shown by the distinguished delegations which represented them at the conference. The Belgian, Portuguese and Spanish delegations were all headed by the Ambassadors of their countries in London. The Union of South Africa sent a delegation headed by the High Commissioner for South Africa. The British delegation was headed by the Right Hon'ble the Earl of Onslow (President of the Conference and President of the Society for the Preservation of the Fauna of the Empire) and included Sir William Gowers, formerly Governor of Uganda and now Senior Crown Agent for the Colonies, and Sir Arnold Hodson, the present Governor of Sierra Leone. All the other powers sent particularly strong delegations and the United States of America, India, and the Netherlands all sent observers to the conference.

From start to finish the conference worked with a will to ensure success. To the observers not concerned with Africa, the degree of unanimity secured by the conference was amazing, and fired them with enthusiasm and determination to impress on their own governments the importance and necessity for doing for their own fauna and flora what the present conference has done for the fauna and flora of Africa.

The result of the conference has been the adoption of a most useful and practical convention, which if ratified by all the governments concerned, will have to a very large degree secured the objects which

the conference set out to obtain. It is impossible in this short article to give the terms of the Convention in full. Printed copies can be obtained from H. M. Stationery Office, London, and I strongly recommend all those interested in the work of the conference to obtain a copy. It is sufficient to say that if the powers concerned ratify the convention, they will have agreed to (1) the establishment within their territories of national parks or strict natural reserves, in both of which the hunting, killing or capturing of animals will be absolutely prohibited, and which shall be placed under public control and be incapable of alienation except by the competent legislative authority. (2) take measures preliminary and supplementary to the establishment of national parks or strict national reserves by setting aside suitable areas to be known as reserves in which shooting shall ordinarily be prohibited. (3) the institution of regulations concerning the hunting and killing of fauna in other parts of their territories which are not included under (1) or (2). The length to which the convention goes in this respect can be judged by the fact that the use of motor vehicles or aircraft for hunting, killing or capturing animals is strongly recommended for prohibition, and similarly their use in such a manner as to drive or stampede or unduly disturb animals for any purpose whatsoever, including that of filming or photographing. The use of torchlights for shooting is also being strongly recommended for prohibition. (4) the strict regulation of traffic in trophies. This not only applies to ivory and rhino horn but to all kinds of trophies, and aims at forbidding the internal dealing in and the export of any trophies other than such as have been originally killed, captured or collected in accordance with the laws and regulations of the territory concerned. For this purpose "trophy" includes any part of an animal, so that the provision covers the internal and external traffic in wild animal meat and horns by poachers and their accomplices.

Finally, the convention provides for the fullest co-operation between the various governments in Africa in carrying out its provisions, and the protocol to the convention provides for further conferences to be held at suitable intervals, the first of which will take place within four years from the date of the present conference, to

discuss the working of the present convention and to consider any improvements necessary.

Through the medium of the Final Act to the Convention an appeal is made to other governments outside Africa to adopt the convention as a model to be applied to their own territories, and it is strongly to be hoped that many governments in other parts of the world will respond, while there is still time to save from destruction the great heritage of wild animal and plant life with which nature has endowed them.

In India much remains to be done in taking action on similar lines to the recent African conference, on lines which will ensure agreement between all the provinces and Indian states in taking joint action for the adequate preservation of their wonderful fauna and flora before it is too late. It is sincerely to be hoped that the Government of India and the governments of all the provinces and Indian states will see their way to take action to show that India not only equals Africa but outsteps her in enthusiasm to preserve the great heritage of fauna and flora with which nature has endowed her.

REVIEWS.

DIVISION OF FOREST PRODUCTS, AUSTRALIA,—REPORT 1932-33. (*Council for Scientific and Industrial Research.*)

This report is full of interesting matter, though no outstanding results or new developments are reported during the year under review. All the main lines of utilisation research advanced steadily and the results were made use of in assisting timber industries.

The seasoning section was kept exceptionally busy. Calls for advice and practical help were received from every State in the Commonwealth. Plans and specifications for 47 kiln installations were prepared and no less than 29 kilns were erected as the result. These kilns cover all types, from those suitable for veneers to those for floorings and joinery stock. Schedules for 17 timbers were developed in the three experimental kilns at the Forest Products Laboratories. The Laboratories were also to the fore in issuing useful publications, and seven trade circulars, three technical papers, and six articles for the Council for Scientific and Industrial Research Journal were published during the year. Lectures and publicity addresses were given to Rotary Clubs, sawmillers' associations and also broadcast. India might well take a leaf out of Australia's pocket-book in this connection.

One of the most important investigations of the year was that in connection with the development of grading rules for Australian timbers. The results have been published in Pamphlet No. 41 of the Council for Scientific and Industrial Research, and are well worth perusal. Another interesting investigation was that connected with standard cases for apples. No less than 32.500 individual apples were examined in this connection and the result of the investigation showed that the Australian dump case gave better protection in transit than the Canadian standard case.

The old trouble of popular names for timbers, a trouble incidentally which is probably more serious in India than in any other country, was taken up by the Standards Association. and a committee has

been appointed to standardise the names of Australian timbers. India already has an official list of standard trade names for the majority of her commercial woods, but the growth of the use of these names is astonishingly slow.

In the reports of the work done in the individual sections there is much of interest both to the research officer and the user of timbers, but space will not permit of a detailed review. Those interested should read the report for themselves. Suffice it to mention that the Australian Forest Products Laboratories have done a very good year's work and have made rapid advance in all branches of their timber utilization and research.

H. T.

RECENT FOREST RESEARCH INSTITUTE PUBLICATIONS.

The botanical branch has just issued *Forty Trees Common in India* (Government of India Press, price Rs. 3/6) which contains line drawings of the twigs, flowers and fruit of forty common wayside trees drawn by Ganga Singh, with a short description of each by R. N. Parker, I.F.S., covering their appearance, distribution, uses and propagation. A handbook of this description fills a long-felt want in educational circles and the small edition of 1,500 copies is likely to be very quickly exhausted. The plates are well reproduced and the book is sure to be popular, in spite of the somewhat "cheap and nasty" appearance of the bilious green cover.

The silviculture branch has issued a *Stand Table for Sal Evenaged High Forest*, by I. D. Mahendru, P. F. S. (*Indian Forest Record*, Vol. XVIII, Pt. XII, price five annas), which forms a supplement to Smythies and Howard's yield table of 1923. This fresh issue does not constitute a revision of the older tables but has been issued in answer to a considerable demand for data which will show in an accessible form the percentage of trees of any given diameter in crops of various diameters. It should therefore be of considerable use to those concerned with *sal* management throughout the various provinces in which it grows. The data for the 1923 tables were taken from about 100 plot measurements but the present stand table is

based on over 400 measurements distributed throughout the four *sal* provinces, only Assam and Madras being unrepresented.

The old *Tables for Use with Brandis' Hypsometer* prepared by Messrs. Manson and Haines for measuring the heights of standing trees has now been re-issued in a more compact size which will fit comfortably into the leather case generally provided for that instrument. The tables remain unaltered but an extra table recently compiled by D. M. Ghosh, P.F.S., Assam, has been included which provides for cases where the observer's eye is on a lower level than that of the base of the tree. Future purchases of Brandis' hypsometer from the Mathematical Instrument Office, Calcutta, will each have a copy of this revised table enclosed.

Recent entomological publications concerning the spike disease of sandal have been discussed fully in the report which was published on pages 695—697 of our October 1933 number and which also appeared in *Nature* of 14th October. The series of studies of special groups of the sandal insect fauna, mostly done by recognised specialists abroad, has been extended with the publication of the following Indian Forest Records :—

Vol.	XVII,	Part	X.—	Sandal	Spike	No 3, Memberacidae, by W. D. Funkhouser.
,,	XVIII	,,	I.—	,,	,,	No. 4, Cercopidae, by V. Lallemand.
,,	,,	,,	II.—	,,	,,	No. 5, Brenthidae and Lycidae, by R. Kleine.
,,	,,	,,	III.—	,,	,,	No. 6, Anthribidae, by Karl Jordan.
,,	,,	,,	IV.—	,,	,,	No. 7, Exocentrus, by W. S. Fisher.
,,	,,	,,	V.—	,,	,,	No. 8, Carabidae, by H. E. Andrewes.
,,	,,	,,	VI.—	,,	,,	No. 9, Neuroptera, by Dr. N. Banks.
,,	,,	,,	VII.—	,,	,,	No. 10, Melasidae and Elateridae, by E. Fleutiaux.
,,	,,	,,	VIII.—	,,	,,	No. 11, Fulgoridae, by N. C. Chatterjee.

The activities of the Systematic Entomologist are continued on the life histories of beetles which are of economic importance as timber destroyers, by the recent appearance of the 13th number of J. C. M. Gardner's *Immature Stages of Indian Coleoptera* (*Bostrychidae*) in *Indian Forest Record*, Vol. XVIII, Part IX.

R. M. G.

THE LIFE OF A TIGER AND THE LIFE OF AN ELEPHANT.

By Sir S. Eardley Wilmot, K.C.I.E.

Arnolds' Kingfisher Library Series, 3/6d.

We welcome the appearance of these two books under one cover in such a cheap and attractive edition, for the late Sir Sainthill Eardley Wilmot's thumbnail sketches of jungle life are deservedly popular and have made the Indian jungle a less mysterious and more attractive affair than the sudden-death school of novel writers who misuse it to make a grim background of their own.

Sir Sainthill retired as Inspector General of Forests in 1908 after a long and honourable career in the Indian Forest Service. He was in the same year as Messrs. Fernandez and A. Smythies, namely, 1873, but unlike them he trained in Germany. Until his death in 1929 he continued an active interest in forestry, both as extra-mural examiner for the Edinburgh Forestry School and as a frequent contributor in the home press. During his service he accounted for some fabulous number of tigers—we hesitate to give an exact figure as we should be told firmly that this was not possible,—and his knowledge of jungle life was prodigious. It is therefore satisfactory to find that his writings are being kept before the public.

His thumbnail sketches of touring incidents and jungle happenings in this collection are skilfully drawn in a direct and simple style which is a pleasing change from the modern tendency to crowd the tale with an undigested jumble of long and pseudo-scientific words. He does not attempt as so many writers do, to place in the brains of the jungle animal any human thoughts and impressions, but confines himself wisely to simple cause and effect. His account of animal behaviour during a forest fire, of a tiger's long-drawn battle with a boar, and of

two elephants' fight to the finish for the mastery of their herd, are particularly good.

R. M. G.

MERIA LARICIS.

The leaf cast disease of larch, by T. R. Peace, M.A. (Cantab.) and C. H. Holmes, B.A. (Cantab.), B.Sc. (Lond.), Dip. For. (Oxon). Publisher Clarendon Press, Oxford. Price 4/- net. (Oxford Forestry Memoirs, No. 15.)

The authors have described one of the most serious and destructive diseases which attack young larch trees in plantations and nursery lines in England and on the Continent. The fungus attacks the needles of larch, causing serious defoliation, and the loss of the needles in the growing season affects the growth of the stand in height and volume. In England this disease is very widespread and appears to be one of the principal factors in the failure of larch.

The paper describes the aetiology of the disease, viability tests of the spores and the methods of dissemination. The pathogenicity of *Meria laricis* has been definitely proved and factors controlling direct infection have been discussed. The fungus in culture shows two distinct strains which differ widely in their cultural characters and interesting observations on their behaviour in larch needle extract have been made. The biology of the fungus has been studied from monospore cultures and a new method of spore isolation has been described.

The inoculation experiments show that the European larch *Larix decidua* Mill and the Western larch *L. occidentalis* Nutt. are highly susceptible while the Japanese, Siberian and Korean larches are extremely resistant. Infection takes place under moist conditions. In dry conditions there is almost a complete cessation of attack, the spores being very sensitive to dry condition.

Various controls by spraying have been tried and sulphur sprays have been found to be very efficacious and a spraying programme has been given. In the end the authors have agreed to the maxim "prevention is better than cure" and have remarked that prevention is usually successful while cure may be regarded as virtually impossible.

It has therefore been suggested that the introduction of European larch in new nurseries should be in the form of seed only, as the worst attack is upon 2-year transplants.

The systematic position of *Meria laricis* is obscure and could be better known by cytological and further cultural studies of these strains. Though the details of the work here and there remain yet to be completed, the authors have given some valuable information, such as, the pathogenicity, factors controlling natural infection, the viability of the spores, etc., and have described useful and practical methods of controlling this serious nursery pest of larch. And also, for those who intend to carry on this work in all details, there are a large number of helpful suggestions. The booklet is adequately illustrated.

K. D. B.

REGENERATION AND MANAGEMENT OF SAL

Mr. Champion's most interesting and illuminating report (*Indian Forest Record*, Vol. XIX, Part 3) throws a flood of light on many of the problems which so many forest officers have been struggling with for years in connection with the moist type of *sal* regeneration in all parts of India. Studying his report carefully, one or two broad generalisations appear to emerge, of paramount importance to this intricate problem.

2. In the first place it appears that throughout the whole geographical range of this species—13 degrees of latitude and 17 degrees of longitude—the combined efforts of forest officers of six provinces spread over 20 years have failed to produce a single compartment of successful *natural sal* sapling crop *de novo* from seed, every case recorded of successful regeneration is from pre-existing stock, coppice, established or whippy growth. Every case where attempts have been made (and they are many) to obtain new natural seedling growth where it did not already exist, has failed.

The obvious and logical conclusion is that where conditions are favourable for *sal* regeneration, there is no need to induce it, as *it is already there*, and where the conditions are not favourable, it is at present hopeless to try and induce it.

3. The second point is equally important. In the moister *sal* types (B 3, 5, 6, C, D.) the biotic influence of management and successful protection appears to give a definite time limit,—varying inversely with the humidity and rainfall, short in C and D, longer in B 3, to the period during which conditions for *sal* regeneration remain favourable. And further, that once the bus is missed there appears to be no later bus (labelled *natural regeneration*) to catch. In Bengal we know this period is very short, in the United Provinces *Bhabar* (B 3 type, Haldwani division) there is evidence to suggest it is about 20—25 years. In typical B 1 (U. P. Hills) we have not reached the limit in 50 years, and perhaps never shall—(but in cold damp valleys of B 1 we have passed the limit).

4. A third important point follows. Wherever this critical time limit is passed or is approaching, natural regeneration is either altogether impossible, or at best very slow. And in the latter case, it seems to me inevitable that it is going to be very expensive, the principal cost being a heavy loss of increment for a very long period.

Mr. Champion emphasises this loss in several places in his report, and suggests trying to avoid it by attempting to induce regeneration in P. B. II. We have tried to do this in the United Provinces (B 3 type) for the last 10 or 12 years both on the working plan scale (Bahraich 1926) and in research and divisional experiments (Haldwani and elsewhere), and so far have failed every time. Ten years of annual burning (sometimes so fierce as to kill large *sal* trees in the overwood) under a fairly dense canopy have completely failed to *eradicate* the evergreen, which comes back as thick as ever directly burning is stopped. Perhaps 10 or 12 years is not long enough ?

Mr. Champion also suggests another alternative, to accelerate the natural *sal* seedlings that still occur in this difficult B 3 type, by giving them full overhead light, intensive rains weeding, soil loosening, and general protection, *i.e.*, give natural seedlings the same treatment and conditions of growth as we give our *taungya* or plantation seedlings. I am myself convinced that in this suggestion Mr. Champion is perfectly right. (Hole proved this 15 years ago in his Dehra Dun strips) But if the only method of saving loss of increment is to apply *taungya* methods to natural seedlings, it would seem preferable to start *taungya* or departmental plantations straight away, as they would certainly be cheaper, and equally applicable.

5. The main lessons of Mr. Champion's report therefore appear to be :—

A. In dry types, protection and shade are all we can provide to help *sal* in its st uggle against adverse edaphic conditions.

B. In moist types.

(*i*) Where conditions are still favourable, very little is required to induce *sal* regeneration, as adequate advance growth is usually already present, and with very little assistance comes up abundantly, particularly with clearfelling.

(*ii*) Where conditions are no longer favourable :—

(*a*) Wherever possible, adopt *taungya* or departmental plantations straight away.

(*b*) Where this is not possible, stop all attempts at conversion to uniform, and eke out the existing stock with selection and improvement fellings, meanwhile carrying on with experiments.

The criterion to decide between B (*i*) and (*ii*) is the presence of *sal* advance growth (either whippy or woody) not liable to be suppressed or seriously worried by evergreen. C. and D. - Same as B. (*ii*), (*a*) and (*b*).

These indications should prove invaluable to forest officers who have for years been struggling with a silvicultural problem that sometimes seemed insoluble, and to working plan officers who have boldly struck out into uncharted seas of *sal* management, sometimes with unfortunate results.

6. One of the most valuable features of this report is the classification of types given on pages 6 and 7. Hitherto it has always been difficult to correlate articles or working plan descriptions of *sal* in one province to the corresponding types in other provinces, but this classification which will presumably be adopted throughout India, now removes that difficulty.

7. Of particular interest to United Provinces forest officers are Mr. Champion's remarks concerning the climax type of moist *sal* forests, *e.g.*, B 3, the most valuable and important type in the United Provinces.

Mr. Champion writes (p. 15) :—" The question arises as to what would be the next stage, and at present it is only possible to speculate. The writer believes that *sal* forest is the true climax, seeing no other potential dominant in the least likely to displace it (*Eugenia jambolana* is the only suggestion), but that the present dense nearly evenaged condition with *sal* forming 75 per cent or more of the top canopy is not natural—it is the result of the history just described—and would be replaced by a more irregular unevenaged form, with a definitely

higher proportion of other species including the more fire tender ones and a semi-evergreen undergrowth."

And again (p. 43) :—" The problem arises as to the lines on which further progress can take place. In view of the virtual absence of high forest long-lived trees any better equipped to replace the *sal*—for *Eugenia jambolana* is almost the only one,—the writer is of opinion that the true climax is likewise *sal* forest, but with a higher proportion of miscellaneous species and a groupwise mixture both as regards species and age classes."

It is remarkable that Mr. Champion, arguing on general principles, *has accurately described a type of forest which actually exists* in Haldwani division and which has always puzzled me. (Examples are Surjia, Patgadh 15, 16 Lakhmanmandi 7 and where we now have teak plantations, Sela 2, and our first *sal taungya* area, etc.) Occupying some of our best *bhabar* soils and terraces, and muddled up irregularly and unreasonably with some of our finest *sal* crops, we find a type of evergreen forest—nothing like Bengal evergreen—with chiefly *Eugenia* and *Mallotus* but also other worthless species, impossible to burn in the hot weather, with occasional scattered hollow *sal* and *Adina* of huge size and fabulous age towering above the general level (presumably relics of some past and more valuable forest), with younger *sal* occurring sometimes as scattered single poles or small groups, sometimes as larger islands, always well grown and of good quality, but (unfortunately) very limited. (Our failed *sal* experiments of 1921 had practically produced a young version of this type with the deer factor limiting the amount of *sal*, *Adina*, and other edible species in the crop). The resemblance to Mr. Champion's speculation is sufficiently striking for us to ask—is this dreadful type our climax ? It is certainly what our adjoining P. B. I. areas would now grow into if we felled the overwood, with more *sal* inside the deer fences and less outside. It is equally certainly not what we want at all!

8. In conclusion, may I venture to congratulate Mr. Champion on producing, so soon after the tour and while it is still fresh in our minds, such a detailed and valuable report, which will prove essential

to every *sal* province and division in India, and which is, I think, one of the most important and valuable publications produced at the Forest Research Institute for many years.

E. A. SMYTHIES, I.F.S.

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EDITORIAL : RECENT STUDIES ON TREE ROOTS.

Considering how entirely dependent we are upon the underground portion of the tree for the manufacture of the timber which is our chief excuse for earning a livelihood, it is certainly surprising how very little the forester knows about tree roots, their development and their requirements.

In his resumé of European Silvicultural Research which has appeared in several of our recent numbers, H. G. Champion referred to the wide interest now being taken by foresters and research workers in root studies. He referred to various studies on peat soils and on soil inoculation experiments, which have borne out the importance of bacterial and fungal constituents of the soil to the welfare of the tree itself, and to the belief that mycorrhiza plays a much larger part in tree development than has hitherto been recognised. A summary of certain recent experiments and of such publications as do not usually reach the hands of the territorial forest staff may therefore be of some interest.

Although earlier workers recognised the existence of some reciprocal partnership between certain flowering plants and the fungi on their roots, the German worker A. B. Frank is generally given credit for the first real development in this study. Since 1885 when he first coined the word *mycorrhiza* to cover the symbiotic partnership of root and fungus, some 300 writers have written about 600 papers dealing with this subject, many workers having obtained inspiration and guidance from Professor Elias Melin of the Forest Mycology Laboratory at Stockholm, who has himself published several contributions since 1922. An English translation of his book "Investigation

of the Significance of Tree Mycorrhiza," published by Edward Bros. Ann Arbor, Michigan, in 1930, price \$2·25, is probably the best summary of our present knowledge of the subject.

There is now a list of over 50 separate species of fungus, practically all Basidiomycetes (agarics) quoted as mycorrhiza formers, while the list of tree species concerned in such partnerships is a very long one. In addition to practically the whole of the Coniferae (pines, firs, larch, cypress, junipers, *Podocarpus, Taxus,* etc.), a very large number of broad-leaved tree and bush species have already been listed in America and Europe, *e.g.*, ash, birch, poplar, willow, walnut, elm, lime, several American oaks (*Quercus alba, coccinea, velutina,* and *rubra*). *Alnus, Carpinus, Corylus, Castanea, Crataegus, Pyrus, Prunus, Sorbus, Cornus, Nyssa, Vaccinium* and other Ericaceae, *Acer, Magnolia, Hydrangea, Careya, Rhus, Robinia, Liriodendron, Elaeagnus Diervilla, Hamamelis, Ostrya, Viburnum, Gleditschia, Morus, Sassafras,* and many other Liliaeacae, grasses, and orchids. Several of these were reported for the first time by L. K. Henry in 1932 (1). The allied question of bacterial infection in the case of certain plants has already been taken up at the Forest Research Institute and has indicated the necessity for using a sample of soil containing the correct bacteria when introducing tree species on ground where they have not been cultivated previously. The work at Dehra Dun on *Casuarina equisetifolia* has been fully described by Aldrich-Blake (6) and more recent work on Leguminosae by Parker (3).

The only references traceable for mycorrhiza proper in Asia are of *Pinus merkusii* in Sumatra (2), and several pines and oaks in Japan, but the Japanese have recently been doing a great deal of research on this subject and will doubtless be able to add to the list other species which occur in India. Our own records report probable mycorrhizae on *Trewia nudiflora*. Most of the recent elaborate research work has been done on conifer seedlings as they lend themselves to easy analysis of soil inoculation and other tests, but enough has perhaps been said to indicate that a very wide field lies open to Indian workers. The infection of broad-leaved species as opposed to conifers is as a rule not so complete, but the absence of root hairs

from all infected roots points to the mycorrhiza fulfilling the role of root hairs, equally well for both these classes of tree. Specimens collected for examination should if possible have the fungus fructification attached to the root on which it is apparently growing. They should be packed in moist moss, as they are difficult to examine once they have dried up. In the absence of porophores, a piece of the hyphal mat should be collected and kept in a phial or bottle filled with water.

The failure of conifer seedlings in *new* nursery soil is a phenomenon well-known to Scottish foresters, and the cure, namely top-dressing the beds with soil from an old nursery or from a neighbouring plantation,—was known long before the scientific explanation had been worked out in detail. A recent example of the practical implications of mycorrhiza was given in West Australia, where it was found to be hopeless to attempt the nursery cultivation of *Pinus radiata* (*insignis*) without first importing a top-dressing of soil from some part of the country in which the pine was already established (4). The absence of the correct soil infection would also explain many failures nearer home, such as the importation of *Pinus caribaea* and *P. palustris* in the Punjab in 1923 ; both of these species germinated well in several of the plains nurseries, but subsequently all died in the seed beds.

Earlier workers classified the main types of mycorrhiza into ectotrophic and endotrophic, depending upon the characteristic internal economy of the partnership. In the former the network of fungal hyphae accumulate in the intercellular spaces between the cortical cells in the outer layers of the rootlet and a thick furry mantle of hyphae replaces the roots' ordinary epidermal tissue. The endotrophic type on the other hand penetrates all through the root and its hyphae become woven into masses which lie scattered *within* individual cells : these infected roots are swollen at the tips and they branch profusely. It is now considered that the same fungus may be in turn ectotrophic or endotrophic because the fungus in the first instance goes wherever it finds the greatest accumulation of starch reserves. Of greater importance to the field observer is the more

recent classification into *coralloid* and *tubercular*,—the former occurs as a series of short roots at the end of a longer main branch like a cluster of corals, while the latter occurs as a tuberous projection which when sectioned shows several rootlets held together by a ball of fungal mycelia. A woolly aphis common on certain conifer roots may easily be mistaken for mycorrhiza.

It is commonly said that the mycorrhiza infection stops further development in length of the rootlet and leads to profuse dichotomous branching, but this appears to be a confusion of cause and effect. Recent studies of uninfected root development in pines by Aldrich Blake in England and Hatch and Doak in America have brought out some interesting facts, namely that the ultimate branching of rootlets is governed in each coniferous species by the number and position of the zylem bundles in the main root (6), that the short rootlets are naturally ephemeral and only the long roots are permanent and can exhibit secondary growth, that long roots are furnished with root caps while short roots lack this structure and that the uninfected short roots of pine continue to show the features of arrested length and dichotomous branching which have previously been suppos dly caused by the fungus (7). Further although the long root tips escape infection presumably by their continuous growth in length and by their protective root caps, these pioneer or mother roots are very few in comparison with the larger number of mycorrhiza short roots (4 per cent and 96 per cent of the total growing root tips in the *Pinus sylvestris* seedlings analysed by Hatch and Doak), so we can assume that the partnership, far from arresting root development, represents a great increase in the functioning surface of the rootlet by virtue of the mat of fungal hyphae which offers an increased area for direct contact with the surrounding soil than the naked root would have.

Mycorrhizae are usually confined to the top 6″ of soil. They are thicker in the raw humus layer of the forest and thinnest in clayey soils. They are almost entirely absent where the soil is baked hard and dry, a point which might have a direct bearing upon the difficulty in regenerating *chir* pine in the lower hills of Rawalpindi and

the North-West Frontier Province. They are at their best in damp warm weather, and they need a lot of rain to restart their development after a hot dry summer, according to American workers. As regards acidity, they will not develop if the soil is either extremely acid, (with a pH value of 3·5 or less), -or if it is definitely alkaline (with a pH value of 6 or over),—but are at their optimum in soil with a mildly acid reaction (with a pH value of 4 to 5·5). (Melin in Sweden and Lohman in Iowa quoted by McArdle) (5). In the case of the Himalayan spruce whose regeneration is a serious problem in the Punjab only microscopic examination will show the presence of the fungus, because in the genus *Picea* no well defined mat of hyphae or coralloid growths are visible to the naked eye (10). In view of the presumably acid reaction of the deep undecomposed needle layer in the spruce belt which may inhibit mycorrhizal development, we should endeavour to find some quick way of recognising spruce mycorrhizae in the field. In the very acid Scottish peats, spruce mycorrhizae are never very numerous and it is only in soils with a high humus content or where artificial manuring has been carried out that mycorrhizae are produced abundantly. Mixed infection of one tree by more than one fungus has been proved in the case of several forest tree species, and two fungi may even overlap on the same root. Mycorrhizae have also been found along with bacterial root nodules on *Podocarpus* in South Africa (9) but cultivation in sterile sand showed that the nodules of the bacillus were more vital to the plant than were the mycorrhizal hyphae.

Our knowledge of mycorrhiza has been extended and defined largely through the laboratory use of pure cultures of the fungi in question and the reinfection of seedlings growing in previously sterilised sand. The obvious limitations of such methods at once strike the practical forester, who wants to know how the partnership behaves in forest humus, not sterile sand. Further progress must depend on closer co-operation between the territorial staff and the laboratory worker, as there are many practical difficulties to be overcome. The literature on the subject is moreover full of broad and unverified statements dating from earlier work, some of which have since been

modified or refuted in view of the more accurate information produced by the new technique. So one should be grateful for the patient efforts of the laboratory workers and also be at the same time chary of accepting the local application of phenomena which have been written up by observers in other countries. The study of orchid mycorrhizae has demonstrated the presence of a special strain of fungus peculiar to each species of orchid, the presence of this fungus being in some cases essential before germination can be achieved. The propagation of orchids being a very lucrative business, the mycologist's laboratory methods have come into common use amongst the commercial firms which handle this trade in Europe and America, pure cultures of the requisite fungi being kept alive on sugar solutions in phials.

The actual rôle of the fungus in its partnership has long been a debatable question amongst botanists, but the two camps which maintained that mycorrhizae must be either entirely beneficial or entirely harmful to the host have now given way to the more balanced view that the partnership is on the whole a sound one for both members. Apart from the proven fact that nursery seedlings often fail to establish themselves in the absence of the correct fungal infection, the evidence from isolated experiments with cultures remains rather contradictory, but speaking generally it can be taken that (*a*) the fungal mat is definitely more absorbent than the uninfected root tip, (*b*) that the fungus is instrumental in freeing more ammonia from the raw humus than the plant unaided could effect—an important point when it is realised that the nitrogen supply is a crucial point in most of our natural regeneration and afforestation problems, (*c*) that the fungus secrets oxidising enzymes, so improving the aeration of the soil (10*a*), (*d*) that the broken down fungal strands within the root tissues are absorbed directly by the tree (11), and (*e*) that the fungal mat of the tree mycorrhiza fends off the attacks of other more virulent fungi which seek entry as root parasites. Some early workers, and more recently W. B. McDougall in America have maintained that the fungus is capable of destroying the tree root, and it is conceivable that in conditions of ill health in the tree crop, the fungus is

capable of becoming partially parasitic upon ailing trees, though this has not been clearly proved to have occurred. From all these points of view the presence and condition of active mycorrhizae should form an excellent indication as to the health or otherwise of our tree crops, did we but know more about the occurrence of such partnerships and their reactions to the various phases in the life of the tree.

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ANDAMAN FORESTS AND THEIR REPRODUCTION, PART III. NATURAL REPRODUCTION.

By B. S. Chengapa, P.F.S.

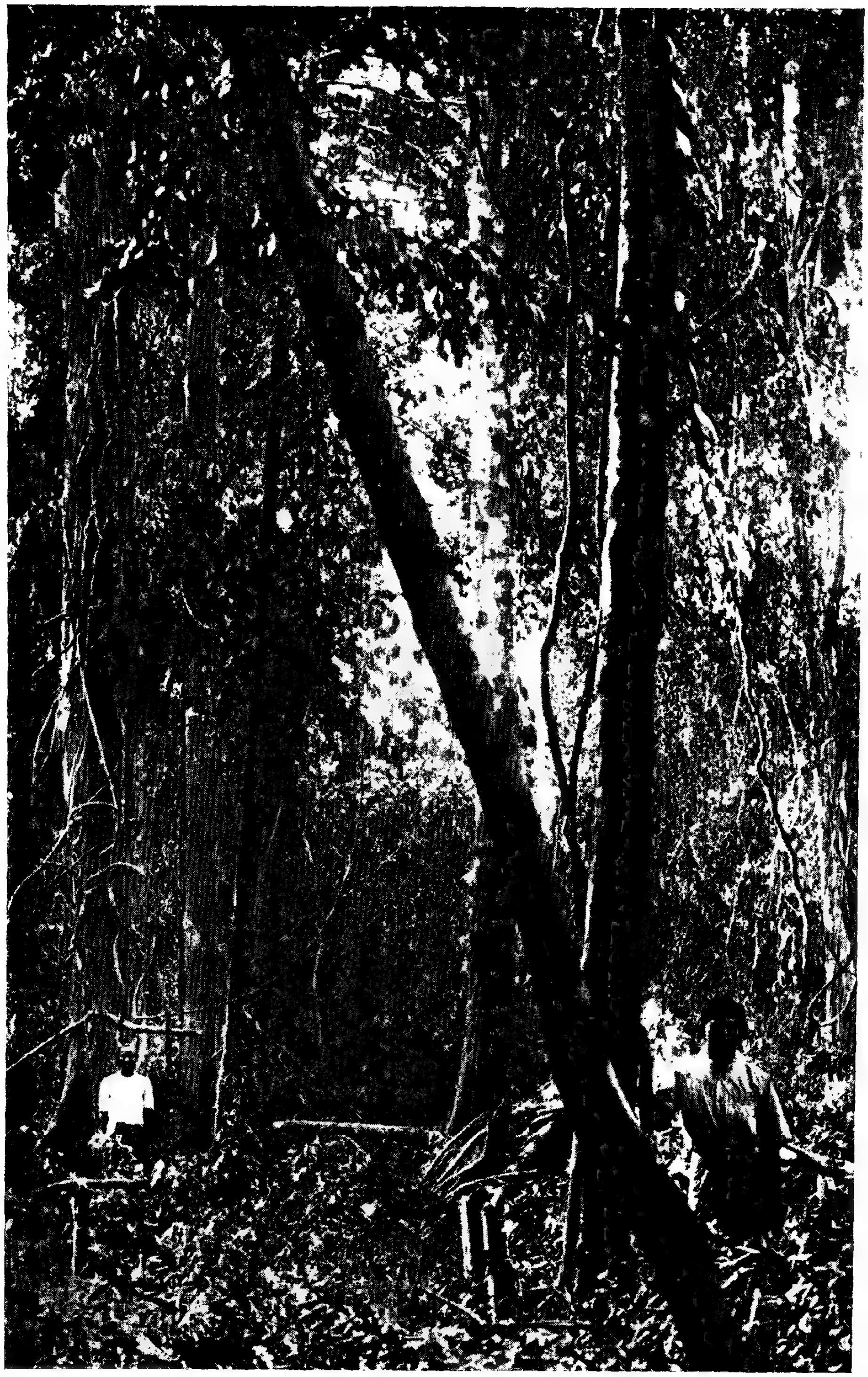
It is common knowledge and it has been observed by successive forest officers that a spontaneous growth of young *padauk* and its associates appears nearly everywhere in the gaps formed by "Selection" fellings. These seedlings die out in the first year for want of light if the gaps are small, and are swamped completely in the second or third year by the rampant growth of weeds and climbers if the gaps are big. It is difficult for any one unacquainted with similar soil and climatic conditions to realise the difficulty of keeping any regeneration area free from weeds in these islands.

Past Work.—In 1911 and 1912, in order to secure the establishment and the development of these seedlings and to induce more

regeneration, cultural operations, *e.g.*, freeing the seedlings and saplings in gaps and clearing round *padauk* seed-bearers, were carried out in Rutland and Baratang Islands. But like the fellings these gaps and clearing were scattered, and like all such work were lost sight of and forgotten. It is now extremely difficult to trace even a single gap and any such gaps are now but a tangled mass of useless evergreen shrubs and weeds. In 1915 therefore, Mr. Bonington in his Working Plan for the Andamans laid down that cultural operations to aid natural regeneration should be confined to definite areas. He proposed that lines 50′ wide should be cleared at suitable intervals in *padauk* forest, teak and *padauk* should be sown in these lines, and the necessary cleanings carried out until the young crop was established. This procedure was found by experience to be impracticable (Forest Administration Report for 1926-27 para. 15).

In 1914 an area of 10 acres in *padauk* forest at Olenleade in the Middle Andaman was selected and undergrowth removed varying from complete to partial clearing. The refuse was stacked in heaps and *padauk* pods were sown broadcast over the whole area. No subsequent weeding or cleaning was done. After two years, only a dense growth of weeds and climbers 10′ high was found with about a dozen young *padauk* struggling through (Forest Administration Report for 1916-17, para. 33).

In 1914-16 an area of 50 acres was demarcated in Bomlungta and improvement fellings including cutting climbers over *padauk* trees were carried out, creating numerous little gaps in the canopy. *Padauk* seedlings soon filled up these little gaps and were kept thoroughly weeded for two years, but the overhead cover closed in again and killed the young crop. The whole area was therefore artificially restocked. In 1916 a small area with a large number of *gurjan* seedlings a year old was noticed in Wimberleygunj fuel working area. All overhead shade was at once removed and the area was thoroughly weeded for two years. Hopes were entertained that this experiment would be a great success, but later it appears to have been forgotten and at present no trace of any *gurjan* is to be found. No further attempt at natural regeneration is thereafter recorded.



Regeneration fellings—*Guitar Island*— Preparatory fellings just carried out. The tree cover is raised to 60 ft; the brushwood is awaiting burning in March.

***Chengapa** : Andaman Forests.*

Causes of failure of natural regeneration.—In 1929 and 1930 the carrying out of mapping and enumeration in the Middle Andaman afforded a rare opportunity of going over about 10,000 acres thoroughly and also seeing the greater part of the forests of Middle Andaman, Baratang and the adjacent islands, and afforded facilities for the study of the different types of vegetation and their present condition. What was noticed as strange then, was the preponderance of mature and overmature timber trees, a totally inadequate representation of the younger age classes and almost a complete absence of seedlings and saplings even though these were found in abundance in tramway cuttings, roadsides, abandoned camp sites and also in recently felled areas. The gaps of the past fellings were an impenetrable mass of climbers and useless evergreen shrubs. The reason for this state of affairs appears to be that almost all the trees in the upper-storey are deciduous ; everything below this is evergreen. The more light demanding deciduous and semi-deciduous species therefore have small chance of pushing their way through the dense evergreen under-storey : in many cases their fruits or seeds, mostly winged, never reach the mineral soil at all. The evergreen undergrowth and the evergreen under-storey thus hinder germination and obstruct development beyond the seedling stage. The removal of these hindrances is therefore imperative for the regeneration of *padauk* and of other desirable deciduous species.

The experiments in the past to raise natural regeneration, though they were confined to small and definite areas from 1914, still centred round gaps and patches created by special fellings. *Padauk* and its associates do not grow well along the edges of plantations and other regeneration areas with a surround of high forest and therefore cannot be expected to do well in small gaps. Large gaps with increased light stimulate weed growth to exuberance in these islands and make cleanings costly. A modification of Mr. Tireman's method by which between 1915 and 1919 he successfully raised natural regeneration over more than a thousand acres in the evergreen Western Ghat forests of Sollkolley valley, Makut range, Coorg, suggested itself as a possible solution.

Present Work.—The regeneration problem in the Andamans is twofold :—(1) The regeneration of areas felled over 10 or 15 years ago and now covered with a dense growth of climbers and evergreen shrubs, and (2) the regeneration of areas felled over recently so that regeneration operations follow extraction closely. In such areas numerous gaps are found with or without a seedling crop on the ground, undergrowth is scanty having been thinned out during felling and dragging, and the soil is sometimes disturbed by the falling trees and also by dragging timber. Experiments in an area of the first type at Porlob Island, and in areas of the second type at Bajalungta and later Interview Island were started in 1931.

First Laltikri Experiment, Porlob.—Porlob Island is covered with deciduous and semi-deciduous forests with occasional patches of evergreen. It was first felled over 15 years ago for *padauk*, *pyinma* and also to a small extent *gurjan*. What now remains is 7 or 8 unsound or immature trees of useful species per acre. (*Gurjan* below 9′, *padauk* below 7′, *white chuglam* below 8′ and the rest below 6′ in girth at the point of felling are considered immature.) These with other less valuable species form a close canopy with very few interruptions ; the underwood is evergreen, thick and impenetrable, with masses of climbers and canes.

In November 1930 an area of 14 acres was demarcated at Laltikri and in November and December all undergrowth was cleared and the under-storey up to a height of 60′ from the ground was felled except in places where the uniformity of the overhead cover had been interrupted as a result of the past fellings. Uniform overhead cover was as far as possible maintained. The object of this cover was to check the exuberance of weed growth and to maintain the original character of the vegetation in case of failure to raise a seedling crop. The refuse on the ground was thick and it was feared that it would prevent the seeds of *padauk* and its associates from reaching the mineral soil. The area was therefore burnt at the end of March. It is impossible to secure a thorough burn in these islands where rainfall occurs almost every month. Heaping and burning was therefore done in

April. At the end of April *padauk* and *white chuglam* fruits began to fall from the mother trees and by the end of May the ground was well covered with self-sown seeds. With tho rains in May, the seed began to germinate and before the end of June the whole area was one sea of seedlings with hardly a square foot of space without some useful seedling or other.

About the middle of July weeds especially *Trema*, *Ipomea* and *Thunbergia* began to appear, but weed growth was feeble compared with that found in open plantations. The area was weeded in July and again in October 1931. In October a representative area was counted and about 12,000 seedlings per acre were found—50 per cent *white chuglam*, 30 per cent *padauk* and 20 per cent *white dhup*, *pyinma* and others. The average height was then about 3′. In October 1931 the canopy was completely removed by girdling all the remaining trees; all such trees died 15 or 20 days after girdling. The sudden removal of the overhead cover induced a rank growth of weeds and climbers and the subsequent weedings became costly, though still comparing favourably with those in a plantation. In 1932 the area was weeded in July and weeded and cleaned in October. In the cleaning, all *white chuglam* interfering with *padauk* were cut, and the total number of seedlings after this cleaning was 10,000 per acre. *White dhup* now appeared to preponderate because of its faster growth and larger leaves though the proportion remained still the same. The best *padauk* had reached 7′ in height and the best *white chuglam* and *dhup* 10′ in height. The total cost till 31st March 1933 was Rs. 42/13/- an acre.

In June and July of 1933 a heavy cleaning was made over the whole area, aiming at 50 per cent *padauk* and 50 per cent other species. A count still showed some 6,000 plants per acre, the mixture being mostly in small groups. Weeds have been killed out completely but climbers are still a source of anxiety and from past experience these may have to be cut every year or once in two years for 10 years or more. *Padauk* has now reached an average height of 10′ though there are individual plants up to 15′. *Dhup* and other species are 15′

high. The early success of this experiment led to its repetition on a larger scale and to a closer study of the light requirements of *padauk* and its associates.

Second Laltikri Experiment.—In November 1931 an area of 74 acres adjoining the last year's experiment was demarcated and divided into 5 plots in which the overhead cover was removed to different degrees in November and December 1931.

Experiment ',—5 acres. All undergrowth up to a height of 10′ from the ground was cut and in April 1932 the *débris* was burnt. With the rains in June, seedlings in profuse numbers came up from self-sown seeds. In July and August they died out completely.

Experiment II,—7½ acres. The overhead cover was raised to 20′. Seedlings came up abundantly 12—14,000 per acre. They lingered on till September and started dying out in October 1932. The canopy was therefore then raised to 60′ by felling and girdling trees in the under-storey. The plants were sickly and only about a foot high and made little or no progress. In the hot weather, April and May 1933, about 50 per cent died but with the rains in June and July 1933 the surviving plants revived and developed well and had reached an average height of 2½′ in October 1933. More seedlings came up in the rains of 1933 from self-sown seeds and made the stocking complete. This area was free from weeds during the first year and the cost was Rs. 10/8/- per acre to the end of March 1933.

Experiment III,—14 acres. All undergrowth and tree cover up to a height of 40′ were cut in November and burnt in April 1932. Seedlings 12—14,000 per acre came up but started dying out in October and November. The canopy was therefore raised to 60′. The seedlings were then only 1′—1½′ high and made little or no progress until the rains, though only about 25 per cent died out. They are now 3′ high. More seedlings came up in the rains of 1933 and filled the area completely. In the first year there was very little weed growth and the cost of formation was Rs. 12/1/- per acre to the end of March 1933.

Experiment IV,—37 acres. The tree cover was raised to 60′ with the monsoon, seedlings 12—14,000 per acre came up and before the end of October reached an average height of $2\frac{1}{2}'$. Weed growth was slow in the beginning; the first weeding was carried out in August and the second in October 1932. In November 1932 it was observed that the seedling crop was not making satisfactory progress. The canopy was therefore raised to 80′. The cost of formation was Rs. 25/6/- an acre to March 1933. The crop was weeded in July 1933 and again in October and November. The canopy is now being raised to 100′ or more according to the requirements of the crop below. The seedlings still number 12—14,000 per acre and are about 5′ high. A cleaning to reduce congestion and aiming at 50 per cent *padauk* and 50 per cent other species will be carried out in December 1933.

Experiment V,—$10\frac{1}{2}$ acres. The tree cover was raised to 80′. Seedlings in like numbers came up early in June and July and occupied every inch of space on the ground. Weeds came in early and grew rapidly, and weedings were necessary three times in 1932, in May, August and October. At the end of October the average height of the young crop was 3′. The cost of formation was Rs. 35/7/- per acre to March 1933. In 1933 the area was weeded three times in May, July and November.

These experiments indicate that the best results are obtained by raising the canopy to 60′ at the outset; the retention at a lower level retards the development of the seedlings and eventually kills them, while the removal of more stimulates weed growth and increases the cost of subsequent weedings. In 1933 therefore another area of 100 acres adjoining the previous areas and also 50 acres in Guitar Island were opened up to give tree cover at 60′ at the outset with the same amount of success,—some 10—12,000 seedlings per acre. The average height of the young crop is already $2\frac{1}{2}'$ and individuals are 4′ high.

Bajalungta Experiments in Middle Andaman Island. First Experiment.—The area is covered with mixed deciduous forest with low evergreen on the drained alluvium along the tidal creek. In

1929 the department with 15 elephants and a petty contractor with 2 elephants and 4 pairs of buffaloes carried out extra extraction of *padauk*, *white chuglam*, *black chuglam*, *dhup*, *papita*, *gurjan*, *taungpeing* and other marketable species, removing about 18 tons per acre. There are still 7 to 8 unsound and immature *padauk* and other useful trees per acre to act as mother trees. The undergrowth and the under-storey were disturbed to a considerable extent by the falling trees and also while making dragging paths. Wherever gaps had been made a large number of seedlings of *padauk* and *white chuglam*, particularly the latter, were seen struggling through the weeds and climbers. Elsewhere no regeneration was found.

In August 1931 an area of 17 acres was demarcated, all undergrowth cut and the canopy raised to 60′. Uniform overhead shade was aimed at. No burning was done as the refuse on the ground was not thick enough to prevent the seeds from reaching the soil. In October it was noticed that the whole area was covered with seedlings of useful species,—5—6,000 per acre. The advance growth had reached 5′ in height particularly in the areas where heavy opening had been made. The tree cover was therefore raised to about 100′. In May 1932 it was evident that the canopy had been opened too soon and too suddenly. Masses of climbers and weeds came in and increased the cost of subsequent weedings. The area was weeded in May and again in September 1932. The cost to the end of March 1933 was Rs. 27/9/- per acre.

In June 1933, a cleaning was carried out aiming at 50 per cent *padauk* and 50 per cent other species, and climbers also were cut at the same time. In November 1933 the overhead cover was completely removed by girdling and a cleaning was again carried out. *White dhup* and *white chuglam* appear to be predominant by reason of their fast growth and bigger leaves. The seedlings still number 6—7,000 per acre.

The most encouraging results obtained in this experiment at little more than half the cost of the Laltikri experiments led to its repetition on a larger scale and to a closer study of the light requirements of the species. The seedlings in this area are about a foot smaller than those of the same age at Laltikri but they are equally healthy.

Natural regeneration—four months old. *Guitar Island*. It is weeded once and the tree cover is raised to 80 ft. The seedlings are *white chuglam* (*Terminalia bialata*).

Chengapa : Andaman Forests.

Second Experiment.—Early in January 1931 a petty contractor with 2 elephants and 4 pairs of buffaloes concentrated his extraction of *padauk* and other marketable species including *gurjan*, on about 300 acres of the drained alluvium adjoining the former area. He worked there more than a year, taking out about 20 tons of timber per acre, consequently the felling had been much heavier than is usually the case. Some 15—20 gaps per acre were created and these were up to 60′—70′ in diameter. There are still 7—8 unsound and immature *padauk* and other useful trees per acre on the area to provide the necessary seeds. A large number of seedlings had come up and were 6″ high in the gaps and many more were in the process of germination.

A portion of this area 68 acres in extent was demarcated, and in October 1931 immediately after the completion of the extraction, undergrowth and under-storey up to a height of 20′ were cut. There was no need for burning. In June and July 1932 the area was weeded and in September 1932 the canopy was raised to 40′. In October the area was again weeded and a stock taken; 8,000 seedlings per acre were found,—50 per cent *padauk*, 25 per cent *white dhup*, 10 per cent *papita*, 15 per cent *white chuglam* and other species well mixed up mostly in little groups. The average height was 5′. The cost till 31st March 1933 was Rs. 11/11/- per acre.

In 1933 the canopy was raised to 60′ in February and again to 80′ in November. The area was weeded twice in June and November. The number and the proportion of the seedlings are still the same, about 8,000 per acre, though *white dhup* and *papita* appear to predominate. The plants are 8′ high and are out of danger from weeds. The climbers however are still a source of trouble. It is hoped that complete removal of the canopy can be effected in February 1934.

Third Experiment.—In 1933 another area of 120 acres including about 20 acres of drained alluvium in which *gurjan* predominates was similarly treated with equally good results. The whole area is now covered with a very promising young crop of *padauk* and its associates, about 10—12,000 seedlings per acre. *Gurjan* seedlings have also come up on the drained alluvium and are growing well.

Regeneration Work on Interview Island.—In 1930 a skidder was erected on Interview Island and extraction of timber was commenced in November of the same year. From the skidder nine cleared lines of an average length of 30 chains and a width of 15′ radiated in all directions covering a circle of about 160 acres in extent. These nine lines were cleared of all vegetation for running the skidder lines. Between the lines (except for small areas from which all logs were dragged by the skidder alone) all logs were hauled by elephants to the cleared lines and thence by the skidder to the logging railway. About 16 tons of timber per acre of *padauk*, *koko*, *gurjan* and other species were extracted. Apart from the cleared lines, the whole area appeared very similar to that extracted purely by the elephants in other parts of these islands. The soil in the lines was well disturbed by the logs coming over them with only their noses lifted. Extraction by the skidder stopped in April owing to the slump in the timber trade.

With the rains a large number of seedlings of *white dhup*, *white chuglam*, *pyinma*, *koko* and *padauk* came up naturally from self-sown seeds. In October they were found varying in height from a few inches to 4′, the best plants being generally confined to the cleared lines. About 6,000 seedlings an acre were found,—*white dhup* 40 per cent, *white chuglam* 30 per cent, *koko*, *padauk* and others 10 per cent. Blanks were rare. The area was weeded and the canopy raised to 60′ in October and November 1931. The young crop responded very well to this treatment; some of the plants have now reached 15′—20′ in height. The cost up to the end of March 1933 was Rs. 14/4/- per acre.

Long Island Gurjan Experiment.—Doubts were entertained whether *gurjan* regeneration could be secured by similar treatment. During his tour of inspection in January 1933, Mr. Blascheck, Inspector-General of Forests, ordered an experiment to be tried on Long Island in a typical *gurjan* area and suggested that the tree cover should not be raised more than 40′ at the outset. Accordingly an area of 30 acres was cleared in January of all undergrowth and the under-storey up to a height of 40′ and the refuse burnt in April.

Gurjan (*Dipterocarpus alatus*) seeded profusely but the paroquets in thousands destroyed the fruits and allowed only a few to reach the soil. In June and July the whole area was covered with a carpet of *padauk*, *koko*, *dhup*, *papita*, *pyinma* and other seedlings, but before they could reach a height of 6", deer browsed them wholesale and destroyed the crop completely.

Though the germination of *gurjan* was poor, there were a number of plants already on the ground being kept back year after year by the thick overhead shade. These older plants responded to the opening by more rapid growth, but almost all the new seedlings have died. *Gurjan* is immune from the attacks of deer.

Guitar Island Gurjan Experiment.—Guitar Island was almost clear-felled in 1922 with a view to regeneration by *taungya*. Subsequently it was found that no one could be induced to take up this work nor was the labour then available sufficient. The island was therefore abandoned with the result that it is now mostly covered by an impenetrable mass of climbers and other useless evergreen vegetation. Few sound *gurjan* which were not felled for want of a market and also some unsound *padauk* and other valuable species occur scattered over the whole area. In May 1933 six *gurjan* trees within about 10 acres were observed to have numerous mature seeds. The undergrowth, a mass of trailing bamboos and a thick carpet of other useless climbers and weeds, was cut and the canopy raised to 40′ in this area. No burning could be done as it was then raining. In June soon after the seedfall these trees were felled and removed. The seeds though winged and falling from a height of some 200′, mostly fell within a radius of 100′ from the stump. Germination was complete in July and gave a dense crop of seedlings in the neighbourhood of the parent trees. More than half of these seedlings, including all those on undecayed leaf litter, died in August when there was a break in the rains. After the end of the rains there were further casualties, particularly among the seedlings which were fully exposed. It appears likely that still more will perish during the coming hot weather. Other species, especially *white chuglam* and *taungpeing* have come up in good numbers and are growing well, so that even if all the *gurjan* disappear, the area will be stocked.

Mention has been made of the successful *gurjan* regeneration on drained alluvium at Bajalungta. The failure to secure survival of new recruitment of *gurjan* either at Long Island or at Guitar Island suggests that *gurjan* seedlings require a greater degree of protection than was afforded in these two experiments. Further experiments will be made.

Summary of Results.—The table below shows the detailed comparative cost of formation of these regeneration areas per acre :—

Particulars of work.	Plantation of corresponding age.	Laltikri natural regeneration long after extraction.	Bajalungta natural regeneration closely following extraction.	REMARKS.
	Rs. a. p.	Rs. a. p.	Rs. a. p.	
Initial Felling ..	34 1 0	6 5 0	3 4 0	Clear felling in the plantation. Preparatory and seeding felling in other cases.
Heaping and burning the slash or refuse	19 2 0	4 7 0	..	1. The use of elephants in the case of plantations is not assessed. 2. A thorough burn is not needed in natural regeneration.
Seed collection and sowing ..	6 15 0	0 6 0	..	Sown broadcast in natural regeneration areas where mother trees did not exist.
Replacing casualties ..	1 0 0	..	..	
Raising field crop ..	2 14 0	..	..	Sugarcane and maize were raised. No demand for them exists.
1st weeding } During	3 3 0	6 2 0	1 7 0	A portion of the cost of raising the canopy is included in the weeding in natural regeneration areas.
2nd ,, } the 1st	7 14 0	5 0 0	4 2 0	
3rd ,, } year.	5 12 0	..	..	
Raising the canopy or secondary fellings ..	..	1 5 0	2 14 0	
Total for the 1st year	80 15 0	23 9 0	11 11 0	Previous plantations in Long Island and Sound Island have cost Rs. 150 –200 per acre.

Natural regeneration—16 months old. *Bajalungta*. The bigger plants are *white dhup* and the smaller ones are *padauk*, *papita* and others. The tree cover is raised to 100 ft.

Chengaga : Andaman Forests.

As has been said before, experiments over 14 acres in Porlob, and 17 acres in Bajalungta, were started in 1931 and by the end of 1933 regeneration has been secured over 626 acres (223 in Bajalungta, 160 in Interview, 193 in Laltikri, and 50 in Guitar). A further area of 300 acres is now under treatment, and it is hoped that in future 500 acres at least will be taken up every year.

Conclusion.—From the results so far obtained it may be taken as conclusive that in deciduous and semi-deciduous forests, in evergreen patches in the deciduous forest, and also in the low-level evergreen forests of these islands natural regeneration of *padauk, white dhup, white chuglam, gurjan, koko* and others, -some of which were very refractory and refused to respond to artificial methods,—can be induced and the best results can be obtained at a cost much below that of artificial regeneration by removing the undergrowth completely, raising the canopy to 60', burning the slash if necessary, and weeding constantly. Equally good results have been obtained at still further reduced costs by following extraction closely and modifying the treatment slightly. Indeed what was said of artificial reproduction as a conclusion in 1921 that "It is so easy and is so much more reliable" can now be applied to natural regeneration with greater force and with the further addition that it is so much cheaper. Mr. Blascheck in his "Note on a tour of inspection of the Andaman Islands, February 1933," says that "A variety of treatment has been tried and the rate at which overhead cover has to be removed has been closely studied; in some cases refuse from the initial fellings has been burnt and in all cases the young crops have been kept weeded for two years. Given skilled attention it seems that it will be possible to restock the semi-deciduous forests in which *padauk* grows at a cost of Rs. 25 - per acre, or even less when regeneration operations follow closely on the extraction of timber."

No finality has been reached and nothing has been standardised yet. The hill evergreen forests still await experimental treatment. The treatment so far developed is a form of shelterwood compartment or uniform system. The initial cuttings,—the removal of the

undergrowth and raising the canopy of the old crop,—correspond to the preparatory and the seeding fellings. It is fairly definite that the final fellings can be effected within three years of the initial cutting. But when and how often the intermediate cuttings should be made are subjects for still further study. The cost of weeding depends almost entirely on the initial and the intermediate cuttings, so there is scope for improvement in the method and consequently for reduction in costs. The mixed nature of the crop will present a serious problem in future tending, which will form a subject fo many years of close study and careful investigation.

ON STARTING A FOX FARM.

By J. M. D. Mackenzie, F.Z.S., M.B.O.U., Sidlaw Fur Farm, Balbeggie, Perthshire (I.F.S. Retired).

On retiring on proportionate pension in 1930, I was confronted with the problem, all too common to-day, of finding a job. Even had the means been available, a life of complete idleness and stagnation had little to recommend it, and without the necessary wherewithal, it became impossible. A proportionate pension may sound munificent to those who have to find the money for it, but it is woefully thin when spread as butter on the bread of everyday life, and something has to be done to help it out. I had heard vaguely of silver fox breeding before I first went out to Burma, and at intervals during the next eighteen years, rather more definite rumours came through, but I was never able to get in touch with anyone who really *knew* anything about it. In 1930 I at last got definite information about a farm within 15 miles of where I was staying, and having tried several square holes, decided to try and make a round one of my own.

Prices were a good deal higher then than they are to-day, and the capital required very nearly choked me off: even then I found later that I wanted more than I had been told, and had to mobilise all available resources to scrape it together. At that time, perhaps

the chief curse of the business was that stock was sold to unwary and optimistic beginners, who seemed to hope that foxes would feed and house themselves with a little gentle 'supervision' and yield a modest annual profit of some 200 per cent on the money invested. There certainly have been isolated cases where this miracle has occurred but it didn't happen to me, and I will offer very considerable odds that it won't happen to you or to anyone else to-day. Jason has already found the golden fleece and removed same.

Having heard of a place where information could be obtained, I paid a visit with my wife, and we were very badly bitten,—even in the first five minutes. The foxes were surprisingly friendly and we found that a man who had recently retired from Burma had had an interest in the farm, but had died a month or so before, after making quite a good start. Two or three more visits, and a good deal of discussion decided us to try our hands at the game and we were lucky in getting the pick of a very fair herd, as being the early birds.

We bought five pairs at first and subsequently one more pair, six in all, and this seems to me to be the best number to start with; it is enough to give considerable experience, and at the same time, not too many to be able to handle while working out the routine of the new farm.

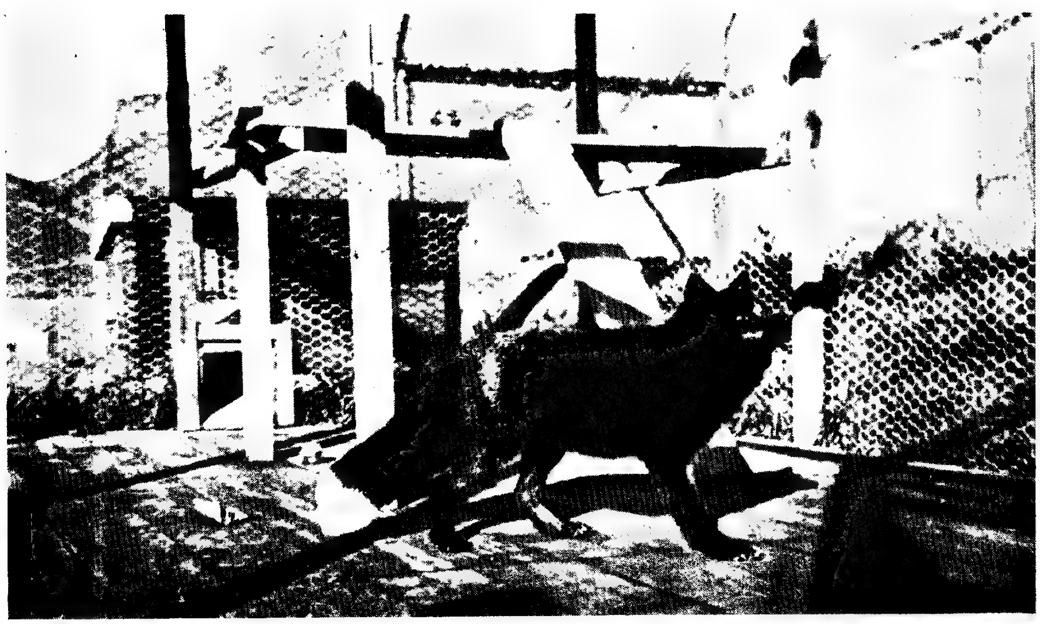
The next job was to find a farm site. We explored a number of places before eventually returning to where we started from, and buying the site owned by the man whose foxes we had bought. It had a five-roomed cottage on it, into which we just managed to squeeze by using half the kitchen for a dining room, while a certain amount of preliminary work had been done towards getting the pens up : our offer was accepted on 22nd October, and I landed up on the 23rd to start work. Optimist ! I was up against all the ponderous business of transferring real estate, and legal heads wagged at me and babbled about searches, missives and similar "abracadabra." Perhaps next year,—Next year! with two months' work to do before we could get ourselves and our beasts in, and the mating season starting in January. I spent two days worrying the life out of two unfortunate solicitors, and at the end of that they found a way to let me get

on, gasping as I left them in much desired peace that it was irregular —most irregular. Eventually the transfer was completed about February, when I had forgotten all about it.

The next thing I got up against was the dole,—a grand institution. Quite a number of men would come and work next Monday, but this was only Wednesday, and to start work in the middle of the week meant giving up 18/- dole and loafing, for 20/- wages which had to be earned. Next Monday: yes, several gentlemen of leisure might oblige me. But to-morrow—what did I take them for? Besides, it was a long way off: would I drive them to and from work in my car? Eventually I found two good men who used to bike out every morning and two more who put up at a farmhouse near by, but even so it was not until Monday that I was able to get started.

The first job was to get the guard-fence up. All fox pens are surrounded by a wire fence,—6 or 7 feet high with a two-foot overhang at the top, dug into the ground 3 feet at the bottom to prevent escapes. This is an expensive item but it pays in the long run, as sooner or later someone is sure to leave a door open, or some particularly persistent animal will bite its way through the wire netting. It meant digging a trench 3 feet deep and about 2 feet wide some 450 yards long. While the men were busy on that we realised the difficulties of starting in a new place with no out-buildings. Our luggage arrived and we had nowhere whatever to put it. Accordingly we invested in a sectional garage 20′ × 10′. That was filled up almost as soon as it was erected. A garage for the car and a lorry was the next item. Then came a sectional building containing 3 rooms which was given the courtesy title of "Office" because it had a table and a chair in it at which I was supposed to write letters. All the rest of the available space was taken up with furniture, luggage and stores. We bought an old American Red Cross Hospital—or rather about half of it—and fixed it up as a 20 feet square workshop. Then another three-roomed sectional building for the man who was to help with the foxes. By means of coming out every day, we managed to get the cottage fit to live in, and by December 1st, we moved in.

Sidlaw Fur Farm at end of first year.



"Major", a very nice 2-year dog fox, in full fur.

Mackenzie: On Starting a Fox Farm.

By this time we had bought an aged Sunbeam landaulette for £5, put new tyres on to her and had the landaulette body replaced by an open truck at the cost of about £10. She was very useful and as a matter of fact, is still in use to-day. I found a demolition contractor in Dundee and spent many hours poking about in his yard—among other things, I found thousands of feet of 2″ piping which I had cut into lengths and used as supports for my guard fence. By December 21st we had managed to complete the guard fence and sufficient pens to house the five pairs of foxes which I then owned, and we got them in on that day. Later on I bought one more pair and with these 6 pairs, by the end of April, we had 25 cubs of which we only lost one which was born dead. One vixen who looked very nice we thought had had no cubs, but the next year we caught her eating them. She was going to be pelted at the end of the year but was killed by accident.

Right up to the end of June we had to leave the farm quiet, but from June 1931 right on to December, we were working hard at getting new pens ready for our increased stock. I think we were lucky, but our actual rate of increase was from 6 pairs bought in December 1930, to 18 pairs in December 1931, and 42 in December 1932, of which 18 had been sold at the same price as we had given ourselves. The stock was good: in 1931, knowing nothing whatever about showcraft, we took a few cubs to the Silver Fox Breeders' Association Show in London, and got one award; in 1932, we took a number to a show in Edinburgh, where we got 26 awards, and to the London S ow again where we got 11, inclu ing 3 firsts. In 1933, when the Show was too early for us, we got 9 awards, and what was even more pleasing, another farmer to whom we had sold stock, won with a cub from our animals. It is, therefore, plain that one can breed good stock, without any great previous experience, but it means hard work.

Pelt prices, after having been very low during the slump, have risen tremendously, and are still rising. Even at the present level, silver foxes yield a good living on pelts alone, if they are properly run. But this is only possible with good stock, and show results

have shown that stock of this sort is almost exclusively bred on small farms, personally run by the owners. "The farmer's eye makes the pig fat" is an old saying, but there are definite limits to the number of animals the farmer can keep his eye on. I put it for foxes at about 50 pairs, and refuse to have more than this on my place. In fact, I am thinking of cutting the number down. The expenses necessary to raising a fox at all are fairly high, and consist largely in the housing and feeding of the parent stock. It is therefore, essential to get as high an average of cubs per vixen as possible : two cubs just about cover expenses, while three or more mean profit ; but while two is a normal average, which can be reached without much care or attention, 3 is not so easy, and 4 is very rarely touched on anything but a very small farm. It obviously doesn't matter whether you have 10 pairs or 1,000, if each pair only just covers expenses, and equally, a few pairs giving say £20—£25 per pair per year profit pays better than a larger number giving a smaller profit. It is absolutely necessary to weed out all doubtful breeders and that term covers a number of things :—those whose cubs lack quality or are not of the most paying type, those who do not breed regularly every year, and those whose litters are small. To be able to do this, one's herd *must* be kept small. There is at the moment a small boom in livestock, which rather obscures the main issue to which we must return in a short time, namely pelt sales. A really good salesman can make a profit just now out of buying stock cheap and selling it dear, but this will not last very long and prospective buyers are advised to insist on figures showing the outturn in cubs per vixen put aside for breeding, that is, kept on the farm after the pelting season ends in January.

There is no doubt that for the right type of man, good with animals and willing to work, there is a good living to be got out of silver foxes, under most congenial open air conditions, but it means learning the job, starting his own farm, and working hard himself. It requires capital,—between £1,000 to £2,000 according to exactly how he sets about it,—and as far as possible he should be on his own, and not dependent on others, in whose mistakes and disasters he may be unwittingly involved.

PRICKLY PEAR AND COCHINEAL INSECTS.

By C. F. C. Beeson, D.Sc., Forest Entomologist, F.R.I.

In recent years interest has re-awakened in India as to the possibility of destroying prickly pear by means of cochineal insects. The success achieved in agricultural and waste lands in many parts of the country has resulted in similar efforts in forests, some of which have been successful and some have failed. Failure is usually due to the use of the wrong kind of cochineal insect on the wrong species of prickly pear.

The commonest species of prickly pear, that have run wild in India, are *Opuntia dillenii*, *O. nigricans* and *O. monocantha*. The cochineal insects involved are species of *Dactylopius*, *D. indicus*, *D. tomentosus* and *D. cacti*. The history of their introduction and spread is of interest.

(*a*). *Dactylopius indicus* is commonly known as the Wild Cochineal Insect, but in spite of its specific name is not indigenous to India. It was the first cochineal insect to be introduced to India about 1795 or earlier, and apparently in mistake for the true cochineal insect, *D. cacti*. Propagation was started in Calcutta Botanical Gardens on *Opuntia monocantha* (a native of Brazil and the Argentine) and also in Madras between 1796—1809. Other introductions were made in 1821 and 1836. As a commercial proposition the industry was not a success for *D. indicus* is much inferior to *D. cacti* as a producer of cochineal dye. The industry gradually lost importance and the work was stopped, but the insect ran wild from the centres of propagation and spread rapidly on the wild prickly pear in different parts of India. By the middle of the nineteenth century much of the prickly pear, *O. monocantha*, in Northern and Central India was infested and destroyed. About this period it was introduced into Ceylon from Madras and established on *O. monocantha* which it soon brought under control. *D. indicus* has followed *O. monocantha* into the sub-Himalayan tract of the Punjab where it periodically destroys this cactus.

Attempts were made in the latter half of the nineteenth century, by distributing *D. indicus,* to exterminate the prickly pear which had become a widespread pest in south India. But the commonest species of prickly pear in the south at that time were *O. dillenii* and *O. nigricans* on which *D. indicus* does not feed, and consequently these attempts were foredoomed to failure. It is curious that it was not till 1911 that this fundamental error was discovered by Burkill. By 1914 the formerly widespread *O. monocantha* had become relatively uncommon in northern India and practically extinct in southern India—a result caused entirely by *D. indicus* which species is itself in consequence comparatively rare. In 1913 *D. indicus* was introduced into Queensland to destroy *O. monocantha.*

(*b*). *Dactylopius tomentosus* breeds only on *Opuntia dillenii* : it does not thrive very well on *O. nigricans* and does not survive on *O. monocantha ;* its preferred food-plant is *O. lindheimeri.* In 1924 the Government of Ceylon received a consignment of this American insect from the Australian Commonwealth Prickly Pear Commission. It was distributed over a large tract of country in the north of the island which was overrun by *O. dillenii*, and in the course of four or five years completely destroyed the prickly pear. From Ceylon it was introduced unofficially into south India and into Mysore in 1926, since when it has rapidly spread in adjacent districts and has been distributed in many localities in the Peninsula, in Madras, Bombay and Central India. By 1930 it was established over an area of 40,000 square miles and by 1931 it had been introduced near Delhi.

(*c*). *Dactylopius cacti* is the true Cochineal Insect, known in commerce as *grana fina.* It is a native of Mexico whence it has been introduced into various countries for the production of cochineal dye. It does not seem to have been established permanently in India. It feeds on *Opuntia coccinellifera* and will not survive on the species of prickly pear wild in India.

Before attempting to destroy prickly pear in any locality it is essential to identify the plant correctly and to use *Dactylopius indicus* on *Opuntia monocantha* and *D. tomentosus* on *O. dillenii.* The most satisfactory way of ensuring that the right cochineal insect is being

used is to obtain pieces of prickly pear heavily infested from a district where the species of *Opuntia* concerned is being destroyed. In distributing the cochineal insect pieces of infested pear should be introduced into clumps, preferably on the shady side, and in the absence of rain and wind so that the young larvæ may swarm and spread on to the healthy prickly pear. The small red larvæ settle and begin to cover themselves with a white cottony secretion in a week or ten days. Gradually the surface of the pear becomes covered with close masses of white cottony material and eventually small tubular cases are formed from which the winged males emerge and after mating die. The life-cycle of the female lasts about 45 to 50 days.

There is no danger of the spread of cactus cochineal insects from *Opuntia* to other plants. Extensive tests with economic plants have been carried out and in no case has a cochineal insect been able to survive on other food-plants. *Dactylopius* feeds throughout the year and is free living for only a brief period in early life and is therefore incapable of existence without a continuous succulent food-supply such as is provided by the botanically isolated group of cacti.

In a previous number of the *Indian Forester* (1932, p. 508) reference is made to the opinion expressed by the Inspector-General of Forests against the introduction from Australia of a prickly pear destroying insect. This insect, *Cactoblastis cactorum*, which is a caterpillar, should not be confused with the cochineal insects already established in India.

Further information on prickly pear control by means of cochineal insects will be found in the following publications :—

T. V. Ramakrishna Ayyar, *The Coccidae of the Prickly Pear in South India and their Economic Importance*, Agric. and Livestock in India, 1931, pp. 229—237.

J. C. Hutson, *Prickly Pear and Cochineal Insects*, Trop. Agric., 1924, pp. 290—292.

F. P. Jepson, *Present Position in regard to the Control of Prickly Pear in Ceylon by D. tomentosus*, Trop. Agric., 1930, pp. 63—72.

Dept. Agric. Mysore, Circular No. 47, 1931, *A mistaken Impression about the Prickly Pear destroying Insects in Mysore State.*

THE FOREST SERVICE OF MAURITIUS.

BY G. N. SALE, B.SC., CONSERVATOR OF FORESTS, MAURITIUS.

1. Mauritius was originally covered with a dense forest of slow growing storm-firm shade bearers containing many valuable timber trees. The Dutch felled all the accessible ebony, and the French settlers cleared large areas for agriculture. By 1870 a few scattered forests remained, of which only a part still belonged to the State. Fears of erosion, of danger to water supplies and even of diminution of rainfall began to haunt the minds of the influential agricultural interest, and as a result, the Government of India was asked to send a forest officer to inspect and report on the remaining forests, and to suggest means whereby the "indirect advantages of forests" might still be enjoyed by Mauritius.

2. In 1880, Mr. R. Thompson, Deputy Conservator of Forests, I.F.S., reported on "The Forests of Mauritius, their Present Condition, and Future Management." He stated that the laws then governing forestry in Mauritius were Ordinances 18 of 1874 and 13 of 1875 "the latter consolidating, as it were; all previous enactments of the same nature." He referred to Ordinance 13 of 1875 as "this excellent forest code."

3. Mr. Thompson found a Forest Department of 30 Forest Rangers, headed by a Guardian of Woods and Forests, under the direction of the Surveyor-General. The functions of these men were purely protective. They enforced the forest laws in crown lands, river reserves, and mountain reserves, reporting thefts and encroachments and prosecuting offenders. In addition, the Superintendent of Botanic Gardens had the supplementary title of Director of Woods and Forests. His forestry duties were to form and tend plantations in the State forests. He had no staff, and no connection with, or authority over, the other forest officers.

4. Mr. Thompson inspected the forests and plantations in the company of the acting Director of Woods and Forests, and his description of the areas and the growth on them form an invaluable record.

He also compiled lists of Indian and Burmese trees which he recommended for introduction into Mauritius, and gave some excellent advice on methods of afforesting steep slopes.

5. His final recommendations included the formation of a coherent Forest Department, still under the control of the Surveyor-General, but with the Director of Woods and Forests as its head, responsible both for protection and technical work. He also advised the early purchase of 15,000 arpents of land for afforestation and protection, thereby increasing the area of the State forests by about 50 per cent.

6. Both of these recommendations were eventually followed, Mr. Horne, Director of the Royal Botanic Gardens, becoming the first head of the Forest Department. During the next twenty years, many fine plantations were formed, mainly of Chinese pine and eucalypts, and the purchase of the land recommended by Mr. Thompson went forward steadily.

7. During this period, very little forest land was cleared for agriculture, and the dread of erosion prevented extensive fellings in the crown forests. As a result, the production of indigenous timber was reduced to a minimum. Owing to the disturbance of the old equilibrium in the primaeval forests, due to the introduction of new flora and fauna, the remaining indigenous forests at this time were in a most unsatisfactory condition, in that overmature trees were dying off, while natural regeneration was in many places entirely lacking. These two factors led to recommendations for the reasonable utilisation of the overmature trees, which were strongly opposed by persons who believed that utilisation resulted in erosion and loss of rainfall.

8. "In 1903, the Mauritius Government applied to the Indian Government for the loan of a forest officer competent to :—

(*a*) Advise on the purchase of lands for afforestation to the value of Rs. 15,00,000 ;

(*b*) Bring the forests under some proper scheme of working, so as to provide some revenue, if possible ;

(*c*) Re-organise the Forest Department ;

and incidentlly reassure the influential party of caution, which objected to any fellings whatever in forests on the ground of diminishing rainfall and consequent injury to cane culture.

9. The officer who volunteered for this duty was Mr. Frank Gleadow, Conservator of Forests, I.F.S. Mr. Gleadow's energy was remarkable, and besides exploring the forests in general, reading up innumerable records and writing a long report, he found time to make detailed recommendations for working the dead and dying trees in certain forests, and to supervise the start of these operations. Felling continued largely on the lines laid down by him, under the control of Mr. P. Koenig, Director of Forests from 1904 to 1928. This work was not interrupted but intensified during the war, when sleepers and construction timber were supplied in considerable quantities from the Mauritius forests, to take the place of imports.

10. This phase lasted until 1928, when the felling of living indigenous trees was stopped, and a start made with the utilisation of the exotic plantations, formed in 1883-1890, on the recommendation of Mr. Thompson.

[Mr. Sale has suggested that any Indian forest officer going home on leave *via* Mauritius and Cape Town should get in touch with him, as he would enjoy a visit from any professional forester.—ED.]

NOTE ON THE FORESTS OF AJMER-MERWARA

By W. F. Coombs, P.F.S.

Early History.—In the year 1819, Merwara was described as an "impenetrable jungle." The Marathas are generally given the credit of the denudation, for by the year 1870, wood of all kinds had become exceedingly scarce and dear. It was Colonel Dixon alone who in the intervening period paid any attention to the planting of trees, and after his death no attempts were made to replant the slopes as they became bare. In the year 1871 the first forest officer was appointed and the Regulation No. VII of 1874 was the first enactment,

which corresponds to the Forest Act. The local villagers were granted rights of grass and wood for their own requirements, and the right of way. In addition they were granted a two-thirds share of the total net profits. These arrangements continue to the present day.

Present Position.—Apart from the reserved forests, there are no forests of any appreciable extent in the districts of Ajmer and Merwara. This is due to the wholesale destruction of the latter caused by unrestricted felling and grazing. Whole hillsides are to be found bare of trees save a few *thor* (*Euphorbia nivulia*) bushes and these too are now rapidly disappearing. The reserved forest are thus a very valuable insurance against famine and provide the ordinary requirements of the villagers. These forests have benefitted greatly by the steady conservation and protection which they have received. Forest fires are generally very rare, but as may be expected, the forest staff are fully employed in the detection of other forest offences. About 5 or 6 offences are on an average being reported daily. Illicit grazing and extraction of produce are the most common. But it is gratifying to observe that the villager has now begun to realise the tremendous importance of forest conservation and he looks forward to the shares of the net profits, which, as will be seen from what is stated below, are now quite considerable.

Finances.—In the decade ending 1890 the average annual revenue was Rs. 9,141/- against an expenditure of Rs. 15,159/-. In the next decade the figures were Rs. 14,719/- and Rs. 16,077/-. In 1902-03 the figures showed a further fall, being Rs. 10,973/- and Rs. 15,520/- when it was stated that the deficit was mainly due to the large quantities of grass and timber given away free to the villagers. In the year 1932-33 the revenue was Rs. 88,273/- against an expenditure of Rs. 60,846/- showing a surplus of Rs. 27,427/-. This has been maintained for the past 7 or 8 years, and the profits which have been paid to the villagers for the quinquennium ending 31st March 1930 amounted to about Rs. 40,000/-. During the same period the value of the grass and other produce removed from the forests by right-holders free or at reduced rates was about Rs. 30,000/- annually. The total receipts of the division are thus a little under 1½ lacs annually.

Silviculture.—The principal species are *dhokra* (*Anogeissus pendula*), *salar* (*Boswellia thurifera*), *kumta* (*Acacia rupestris*), *babul*, *khair*, *orinja* (*Acacia leucophloea*) and *khejra* (*Prosopis spicigera*). All coppice well and consequently the system of coppice with standards is the only easy one. Frosts are rather frequent especially in the deep valleys, while elsewhere the retention of standards is necessary for shade and seed. The provision of the working plan which sets aside half of the felling series for entire rest is a very sound one and has done probably as much good as the actual working in the other half. All attempts at artificial regeneration have failed in the past after the expenditure of lacs of rupees, and it is unwise to continue it on those lines. The sowing or planting work done in scattered patches all over the forests were scarcely likely to succeed owing to uncertain rains, want of proper fencing or protection against injury, entire lack of weeding, and lastly—but probably the most important—the lack of shade in the hot season. Damage by pig, sambhur, hare and the land lizard accounted for what did manage to survive. The broadcasting of seed of the common species by forest guards in *thor* bushes was more successful, but at the same time these efforts were not concentrated enough to be appreciable. At present only the really large blanks in the coupes are being sown up after careful fencing of the site. Weedings are insisted on. The system followed is the trench and mound method common in the Cawnpore Afforestation Division. An experiment which has just been tried is as follows. The trench which is about 10′ long is made about 18″ deep and 10″ wide. The soil is thrown back to a depth of about 9″ and the seed is sown at the bottom of the trench. The top of the trench is covered with thorns, etc., for protection against injury, as well as to provide shade. The idea is to conserve as much moisture as possible during the hot season when the mound literally bakes.

So far as coppice regeneration goes, the counting of the successful stools gave the high figure of about 95 per cent. It is also certain that with the shade and moisture provided naturally in the forests, the natural regeneration of the common species is slowly progressing. Certain shade bearers, *e.g.*, *nim*, *dhak*, *kadam*, etc., are never felled and these species are gradually increasing.

General.—The division is fairly well provided with roads and rest-houses. The sale of minor forest produce is extending, which includes honey, wax, lac, leaves, etc. The division is rich in minerals, *e.g.*, lead, mica and asbestos, but owing to high costs of extraction, these have not been worked. Stone, lime and road metal are extracted in large quantities.

The shooting is generally good. Panthers are common, with an occasional itinerant tiger : one visited the forest 4 miles from Ajmer the other day and killed a divisional buffalo. Partridge, grouse, and quail are abundant. Duck during the cold weather on the numerous lakes are as good as anywhere else. Crocodile may also be obtained in nearly all the village tanks. In the deer line, chinkara and black buck are common. Sambhur are at present protected. Jungle fowl different in plumage to the *bhabar* stock and of larger build, are to be had in the Todgar sub-division.

TENTAT VE GRADING RULES FOR STRUCTURAL TIMBERS

BY L. N. SEAMAN, M.A., B.SC., M.E.I.C., TIMBER TESTING SECTION, F.R.I.

Tentative grading rules for structural timbers have been prepared and revised from time to time by the Timber Testing Section of the Forest Research Institute at Dehra Dun. The last revision published appeared in the Second Interim Report on the work under Project No. 1 by the Section of Timber Testing in 1926. It has since been suggested by an eminent engineer that, although these rules are not final and will be subject to further revision when the testing of timbers in structural sizes under Project No. 2 is completed, their publication would be of considerable value to engineers and architects using timber for structural purposes. For this reason the rules, essentially as they were published in 1926, are now included in this article together with certain notes on their limitations or modifications with reference to some of the Indian species.

In order to divide timbers by means of grading rules into classes which will vary progressively in strength from the poorest to the best, it would be necessary to place certain limitations on defects as

found near the centre of the length of the beam and near the upper and lower surfaces, and to permit these defects to increase gradually in seriousness as they were found nearer to the ends of the beam, or nearer to the centre of its height, the central portion of its length and its upper and lower surfaces being the portions which are subjected in practice to the greatest stresses. A rule of this kind, however, is much too complicated for application in every day practice, and the present revision, it is believed, while simple of application, does not depart far enough from scientific considerations to cause material waste in the use of the timber.

The following rules are not intended to apply to the trade as a basis of agreement between seller and purchaser, but are meant as a guide for the engineer in the selection of his material for certain purposes, and in determining what working stresses to use in figuring the dimensions of timbers.

General Requirements.—" Structural Grades" shall be of sound wood and well manufactured, with square edges; occasional slight variation in sawing will be allowed. All timbers containing active borers must be rejected. Structural timbers may be considered as divided into No. 1 Structural Grade, No. 2 Structural Grade, No. 3 Structural Grade, and Culls. No. 2 Structural Grade shall be known as the " Standard Grade " and the other grades can be derived from its specifications. Knots in clusters will not be permitted in any grade.

Heartwood and sapwood are of equal strength, and heartwood requirements are based only on considerations of durability when no preservative treatment is used, or on appearance. There should be no restriction of sapwood when treated timbers are used.

Weight.—No pieces of exceptionally light weight should be used where strength is required.

Standard Grade (No. 2 Structural Timber) Beams.

1. *Knots.*—The size of a knot shall be taken to be the mean of its greatest and least diameters.

(*a*). *General.*—The sum of the diameters of all knots within the centre half of the length of the beam shall not exceed the width of the face in which they occur.

(*b*). *Maximum Size.*—The maximum size of a knot shall be as follows :—(It is taken that the wide faces of beams are placed vertically and their narrow faces horizontally).

Width of face in inches.	Maximum size of knots in inches.	
	Narrow face and top and bottom $\frac{1}{4}$ of width of wide face.	Centre half of width of wide face.
3	$\frac{3}{4}$	$\frac{3}{4}$
4	1	1
6	$1\frac{1}{2}$	$1\frac{1}{2}$
8	$1\frac{3}{4}$	2
10	2	$2\frac{1}{2}$
12	$2\frac{1}{8}$	3
14	$2\frac{1}{4}$	$3\frac{1}{4}$
16	$2\frac{1}{2}$	$3\frac{1}{2}$

(*c*). Loose or unsound knots, or grub and borer-holes, shall be limited to the same dimensions as sound knots.

2. *Shakes.*—The width of a shake shall be taken as the length of its vertical projection measured on either end of the timber. The maximum width of shakes shall be as follows :—

Width of face in inches.	Maximum width of shakes in inches.	
	Green timber.	Seasoned timber.
3	$\frac{3}{4}$	1
4	1	$1\frac{1}{3}$
6	$1\frac{1}{2}$	2
8	2	$2\frac{5}{8}$
10	$2\frac{1}{2}$	$3\frac{1}{4}$
12	3	4
14	$3\frac{1}{2}$	$4\frac{5}{8}$
16	4	$5\frac{1}{4}$

3. *Angle of Grain.*—The angle of grain shall not exceed a slope of 1 in 15.

4. *Sapwood.*—Sapwood shall be permitted in temporary structure . In permanent structures, each of the four faces of the beam must show at least 85 per cent heartwood, unless the timber is thoroughly impregnated with creosote or other reliable wood preservative

No. 1 Structural Grade.—No. 1 Structural Grade shall admit defects one-half as large as those permitted in the Standard Grade, except that no loose or unsound knot shall be admitted. The angle of grain shall not exceed a slope of 1 in 20.

No. 3 Structural Grade.—No. 3 Structural Grade shall admit defects one and one-half times those specified for the Standard Grade, and the angle of grain shall be restricted to a slope of 1 in 12.

Culls.—Timbers falling below the specifications for No. 3 Structural Grade shall be known as *Culls.*—Such timbers, if reasonably sound and free from decay, are satisfactory for use in the walls of small buildings, where stiffness rather than strength is required.

Notes.—1. In structures where the timber is to be subjected continuously to the maximum computed load, the allowable modulus of elasticity should be divided by 2.

2. The value given for compression along the grain should be used for end-bearing and for short columns. For compression members with an unsupported length greater than about ten times their least diameter these values should be reduced according to accepted column formulae.

3. These rules, used in connection with the *Working Stresses* published in Indian Forest Records, Vol. XVII, Part VII (" Interim Report on Work under Project No. 2,"—Seaman), will ensure economical and safe use of timber in structures. When so used the published safe working stresses are for the " Standard Grade " also called " No. 2 Structural Grade."

4. When " No. 1 Structural Grade " is used the working stresses for compression, bending and shear should be multiplied by 7/6.

5. When "No. 3 Structural Grade" is used the working stresses for compression, bending and shear should be multiplied by 5/6.

6. "Culls," if they are moderately sound and free from decay and active borers, are suitable for the walls of small buildings by using 3/4 of the working stresses for compression, bending and shear.

7. The working stresses presented in the tables are in most instances divided into 3 classes, namely for inside locations, outside locations, and wet locations. These classes are meant to apply to uses in which the timbers are respectively :—

(*a*) continuously dry and protected from the weather,
(*b*) occasionally subjected to serious wetting but quickly dried, and
(*c*) subjected to practically continuous water soaking, or contact with the ground.

This is a simple method of making allowance for the deterioration probable in any but dry, sheltered locations. Whether or not it is the best method is a matter for engineering judgment. Another method, favoured by some, is to use always the working stresses stated for "Inside Locations" and then, when the structure is to be exposed to less favourable conditions, to use timbers somewhat larger than the computed sizes. This method requires experience and sound judgment, as the extra size of the timbers is meant to allow for the deterioration which they may be expected to suffer during the life of the structure.

8. Only one value is given in each case for Modulus of Elasticity. This value is the average of test results without the application of any Safety Factor, as it is intended for use only in the computation of average deflections in beams. When the Modulus of Elasticity is employed for calculating the deflection of beams subjected to continuous loading, the value shown in the Table should be divided by two. No allowance is made in the value for Modulus of Elasticity, or for Shearing, on account of inside, outside or wet locations.

9. The values in the column headed Horizontal Shear are to be used in calculating the longitudinal shearing stresses in deep beams.

When dealing with shearing stresses in fastenings, at mortices, etc., the values found in the column headed Shear Along Grain can be used.

10. Very many of our indigenous woods are characterized by interlocked fibre. When such is the case the requirement relating to straightness of grain does not apply when the timber is examined on a tangential face, as the slope of the grain varies in successive layers of the wood. With experience it is possible to recognize the presence of interlocked fibre by the appearance of the wood, the interlocking being indicated by the striped appearance known as *ribbon grain* on *radial* surfaces. If any doubt exists it can be settled by splitting a small block of the wood *on the radial plane.* In wood with interlocked fibre the split surfaces will not be flat, but will be deeply corrugated like the surface of a washboard.

11. Though grading rules for posts or struts are not presented at this stage, it will be satisfactory, for the present, to impose on such members the same restrictions as are specified for the "centre half of width of wide face" in beams.

RINGING OF DUCKS IN DHAR STATE.

By Bhai Charan Das, Conservator of Forests, Dhar.

His late Highness, Lt.-Colonel ir Udaiji Rao Paur, K.C.S.I., ruler of Dhar State, C. I., was a student of natural history; he was keenly interested in wild life, and its proper preservation. He always kept a detailed account of the various shooting trips and excursions and consequently had gained so much experience and information that he compiled a book on shooting "With Rifle and Gun In Hand in the Dhar State." Sir Udaiji was fortunate in having plenty of game from big game down to birds in his state. The Nimar Range running along the Nurbuda river abounds with all the kinds of big game usually met with in Central India, namely tiger, panther, bear, sambhar, chital, bluebull, pig, etc. Dhar and Badnawar *tehsils*,

comprising portions of the Malwa plateau, provide excellent ground for shooting black-buck, partridge and florican while tanks at Dhar and Mandu remain full of duck and snipe in the winter.

Sir Udaiji Rao once happened to read accounts of the ringing of wild fowl and other migratory birds carried out in foreign countries and he was so interested in it that he determined to try the same in Dhar with a view to find out how far north the birds which visit Dhar migrate, and whether they visit these parts again each winter. In October 1924 the contemplated scheme was referred to the Secretary of the Bombay Natural History Society and he supplied five hundred aluminium rings bearing serial numbers and the inscription "Inform Maharaja Dhar" at a cost of Rs. 75.

The work of catching live ducks was taken in hand but it was soon realised that the local people did not know how to do this, hence four *shikaries* were called for from Lucknow who brought with them four nets each about thirty feet long and twelve feet high with a mesh of an inch and a half made of strong cord, of the same type as is generally used by fishermen. The selection of the site where nets should be fixed up is an important matter. The place selected was quite close to the high weed cover so that the net could not be seen from a distance by the birds. The birds when frightened generally take flight for rest and feeding into thick weeds. It was in the direction which the birds took while going from or coming to the tank. The place was protected from high winds so that the net did not swing and the birds never saw it. Had they seen it they would have grown suspicious and would never have come towards it.

After selecting the site for the nets, strong bamboos sixteen or twenty feet in length were firmly driven in about two or three feet into the bed in one line. These posts stood at a distance of about ten to twelve feet from each other. The net was fastened to the posts. The lower end of the net was taken up and loosely tied to the bamboos about three feet above the water level. By means of small bamboo posts the lower portion of the net was supported and it looked like a long channel or pouch with an open mouth and a V-shaped bottom.

The birds when once in the V-shaped pouch cannot get out of it as they cannot get enough space to fly.

Having fixed the net a beat was started, when there was no moon because in the moonlight the birds can see the net and carefully avoid it. The water being too deep for wading, two small boats were engaged for driving the birds. The beat was silent until the birds were about thirty yards or so from the net when the beaters began to call loudly and one of them, who was in the centre of the line, set on fire a small bundle of grass which he carried with him to frighten the birds which immediately took flight. Those which happened to strike against the net slipped down and fell into the V-shaped pouch out of which they could not escape. At the end of the beat the birds were taken out of the bag and kept till next morning in nets and baskets specially made for this purpose. As the birds had not become very suspicious this process was continued for two days. In order to collect most of the birds in that tank a few guns were posted at all other tanks in the neighbourhood.

In order to avoid confusion great care was taken as regards correct identification and naming. There were some birds which do not migrate hence these were not ringed. After identifying the birds their Latin names were invariably entered in the register together with their locality, sex, date and the number of the ring used. The ringing consisted of fastening a light aluminium ring of appropriate size, bearing stamped number and address on to the tarsus region of netted birds which were afterwards released. Particular attention was paid in fastening the rings. The correct size of ring is such that it moves freely up and down the tarsus and cannot be pulled off over the feet. Young birds, specially ducks, have thinner legs when they are young, therefore it is advisable not to ring them until they are fully grown else the ring would slip off or if overlapped would cause suffering to the birds. Injured or sickly birds or those which appeared to have been in captivity for some time were not ringed at all. By the end of February two hundred birds were ringed and released. A proper account of each of these birds was kept. The work was stopped in the beginning of March, because the

birds leave then in great numbers for cool places. The total expenditure on this work came to Rs. 475/-.

Out of the two hundred birds ringed and released in February 1926, we were informed about eight of them as follows :

1. On Lakoda tank, North of Fatehabad (B. B. & C. I. Ry.) Gwalior State, on 4th March 1926, one drake tufted pochard carrying ring No. 29 was shot by Lt. W. A. Gimson, I. A.
2. At Jand (N. W. R.), District Attock, Punjab, Mr. Mohammad Akbar shot one widgeon in May 1926, bearing ring No. 92.
3. At Lalwal, District Attock, Punjab, Bagh Ali Shah, Head-Constable, shot one coot bearing ring No. 94 on April 5th, 1926.
4. At Barnaul, Siberia, one male *Nyroca ferina* pochard carrying Dhar ring No. 58 was shot in May 1926. (The information supplied by Professor Harmaun Johansery of Tamsk University).
5. At Kalgot (Omsk Ry.), West Siberia, one female *Anas penelope* (widgeon) carrying Dhar ring No. 38 was shot.
6. Professor T. F. Sonkaff of the Institute of Rural Forest Economy, Omsk, Siberia, wrote that a widgeon (*Mareca penelope*) bearing Dhar ring No. 43 was captured near the town of Tara in Siberia.
7. At Dhar, C. I., Col. Devonport shot one *Nyroca ferina* pochard, on 28th December 1928. It carried a Dhar ring the number of which was invisible.
8. The curator of the Sibirsker Museum reported that a female pintail bearing a Dhar ring with number illegible was caught on the Tara river in Siberia on 29th May 1929.

The results of the experiment were so interesting and encouraging that in 1928 the Bombay Natural History Society started a regular scheme for the marking of migratory birds through the assistance of members in various parts of t.e country with a view to advance the

present extremely meagre knowledge regarding the seasonal movements of our migratory birds. The Society had been in communication with Russian authorities who had kindly agreed to co-operate and report to the Society about the Indian ringed birds recovered in Siberia, where the majority presumably retire for breeding purposes. The Russian authorities translated the letter of the Society containing particulars of the proposed scheme and published it, for information of the general public, in ornithological and sporting magazines throughout Europe, Russia and Siberia. The Russian authorities also informed the Society that bird ringing was also done there on a large scale over a considerable part of Asiatic Russia by the Biological Station of young naturalists at Moscow and asked that any rings which might be recovered from the birds were returned to them together with full particulars as to the species, sex, locality and any other point of interest regarding them.

The work started by late Maharaja Udaiji Rao has created great interest and curiosity in foreign countries, and an article which appeared in the *Ornithological Monthly Journal* (Vol. XXXVI) for May 1928 described how some of the Dhar rings collected in Russia had been discussed in the Journal of Siberian Ornithology. After the death of the Maharaja Udaiji Rao Puar the Bombay Natural History Society requested her Highness the Maharani Saheba of Dhar to become Vice-Patron of the Society and have the ringing of birds continued by the Forest Department of the State. In response to this the work was re-started in 1929. This time 186 birds were ringed and released at a total cost of Rs. 300/-. Diwan Bahadur K. Nodkar, Chief Minister of Dhar, also took a great interest and gave every possible assistance.

A PLEA FOR OUR SOFT WOODS.

By W. C. Hart, P.F.S.

In view of the fact that experiments with the use of charcoal gas as fuel for automobiles have been perfected, and the apparatus hes already been fitted to many cars and lorries in Europe and is

likely to come to India soon, I suggest that it is time we ceased our endeavours to eradicate soft woods from our timber and fuel areas by the usual method of mutilating the stumps and leaving the stems to rot.

Who can tell whether when the charcoal industry develops in India as fuel for automobiles and probably other engines, certain soft woods which now appear to us as useless for timber purposes, may not be preferable for the generation of carbon monoxide ? It is very interesting to learn that to revive the charcoal industry in India Colonel Noel, who has been appointed Commissioner for Development for the North-West Provinces of India, left the Royal Automobile Club on October 18th with two Rolls Royce engines, one driven by petrol and the other by charcoal gas, on an overland journey of 6,000 miles. Twelve pounds of charcoal are said to be equal to a gallon of petrol. Think what it will mean to the Forest Department, and to us forest officers, when charcoal gas automobile engines come to stay. As the Rolls Royce Company has moved in the matter, some interesting developments must be expected. If certain soft woods can produce a good quality charcoal with small ash content, we can well see what a tremendous demand must be met, and to this end this is an opportune moment to consider the technical details of manufacturing charcoal and to establish the relative value of the product obtained from different soft woods.

It is hard to understand why we should wage war on any plant produced by nature with a definite object, unless we can systematically prove that there is any real benefit to be derived by getting rid of it. For example, take the case of *Givotia rotleriformis* and *Sterculia urens*, which were formerly viewed as worthless species encumbering the ground. Many have been the working plans that prescribed the eradication of these trees. Where I am now working, they fetch an equal if not better price than hard woods in the round, the timber being used for frames for the manufacture of slates for school children. *Givotia* in particular is quite a good wood ; I have a plank ½″ thick and about 15 inches broad, which was sawn off a freshly cut tree two months ago. It has not warped or cracked a bit. It planes excellently, with great ease, and yields a very smooth surface.

Take the case of prickly pear, whic we have eradicated by means of the cochineal insect. This had its uses as a nurse, in denuded areas, to young tree species. It also provided a good fence to the ryot. Most forest officers must now agree that the prickly pear was a friend in disguise, for in its absence there is a heavy drain on the forests for fencing materials for the ryot. *Lantana* is considered a pest, but has nursed millions of sandal plants to maturity. Without its help most of our sandal forests could never have existed. Even grass has its uses for fodder, for the fixing of the soil, and as a means of absorbing rain water. We see therefore before us the evolutionary work of nature in the definite order of grass, herbs, shrubs, softwooded trees, deciduous species and finally evergreens. The two final stages cannot be reached by natural methods unless the previous ones are gone through. It is fairly obvious therefore that by attacking the soft woods we are far from gaining time, but rather putting back the clock, so to speak, for in the gaps created by felling one softwooded tree, at least a dozen more spring up.

TWENTY WEST AFRICAN TIMBER TREES.

By L. Chalk, M.A., D. Phil., J. Burtt Davy, M.A., Ph.D., H. E. Desch, B.Sc., M.A., A. C. Hoyle, B.Sc., M.A.

No. II of Forest Trees and Timbers of the British Empire.

The work embodies the botanical essentials with wood descriptions of twenty West African timber trees selected chiefly on account of the importance of their timbers.

The species are first dealt with under their respective genera, the generic characters with keys (or references to them in No. I of the work) being given to distinguish the other allied West African species.

Under the specific headings a full list of common and vernacular names with copious references and the botanical name with synonyms is given. This is followed by a good botanical description which, with the excellent botanical plates and photographs showing the habit of the trees and, in some cases, the bark characters, leave, from the systematic aspect, little or nothing to be desired as far as the forest officer is concerned.

Descriptions of the wood have been dealt with very fully under 5 main headings, namely general properties, macroscopic and microscopic features, material and literature. The detailed macroscopic features that are given, will be helpful to the forest officers and others who are interested in the identification of these timbers in the field, while the description of microscopic features leaves nothing more to be desired from the point of view of the wood anatomists. In accordance with the suggestions of the International Association of Wood Anatomists, some changes have been made in the terminology used for the description of wood. The authors have judiciously avoided describing any timber for which they had only one wood specimen at their disposal, in view of the fact that a single specimen does not give the range of variation that is likely to be found within a species.

In the case of a genus containing several species, general properties, wood anatomy (both macroscopic and microscopic combined) and a key to the species based on macroscopic and microscopic features, have been given. The key is well constructed and easy to follow. Photomicrographs of transverse section at 30 magnification and that of tangential at 100, are given. They are well reproduced and show very clearly the anatomical structures of various timber species included in the book.

The work has been put together in a remarkably useful manner and should prove of much value in the hands of forest officers and others in West Africa. The get up, printing and reproduction of the plates, is of the usual high standard of the Clarendon Press.

C. E. P. AND K. A. C.

EXTRACTS.

EMPIRE TIMBER.

Sir John Stirling-Maxwell, chairman of the Empire Forestry Association, addressing members of the Royal Empire Society at a luncheon in the Cannon Street Hotel recently, said the substitution of Empire timber for foreign timber in the British market could be brought about only by stages spreading over a considerable period.

Hardwoods seemed to offer a better field for Empire trade than softwoods, for nearly one-third of our imports came from Empire sources, and, with the addition of home-grown supplies, provided about half the requirements of the United Kingdom. By raising import duties stage by stage the transfer from foreign to Empire hardwoods could be brought about. It was unfortunate that since the financial crisis of 1931 the forestry staffs had been cut down in almost every part of the Empire, a form of economy that seemed short sighted.

For beauty and durability no hardwoods could beat those from the Empire, especially those from Canada, India, West Africa, Australia and New Zealand. It was becoming the custom to use nothing but Empire hardwoods in public buildings in Great Britain. Unfortunately there was no central depôt where these hardwoods could be studied, though many of them were on view at the Dominions offices in London, at the Imperial Institute, and at the research station at Princes Risborough, where so many of them had been tested.

Of the 18,000,000 cubic feet of softwoods imported into the United Kingdom annually, less than 8 per cent. came from within the Empire and about 2 per cent. were produced in this country. Only Canada could supply the Empire softwoods that would be required to take the place of the foreign, but two fundamental difficulties that arose in considering supplies from the Dominion were that hitherto Canada's chief market had been the United States, and that ships bringing timber from Canada would have to return empty unless Canada took many more goods from us than she bought to-day. It was unfortunate that the British delegation to the Ottawa Conference did not include authorities competent to give independent advice on the subject. So far as the matter had been considered at all, negotiations seemed to have led to nothing but misunderstanding.

The British Government seemed to have been very weak in dealing with the Russian timber issue. It was a great injustice to all who produced timber under fair conditions to see other timber produced under unfair conditions under-selling them in the British market. He would like to see Russian timber imports completely stopped in this country. Every branch of our timber trade should be studied to see how far supplies could be obtained from home or Empire sources, and protection then given to the home and Empire producers against foreign competition. There was no reason why most of the mines in Britain should not be supplied with pitwood grown in the United Kingdom ; an attempt was actually being made to arrange this.

Very soon he hoped that Empire suppliers would be able to supply the Post Office and the Electricity Board with all the telegraph and transmission poles that they

required. Trades like boxmaking could be supplied with raw material from this country or Canada. It would be necessary to guarantee supplies over a period of years at reasonable prices, and if that were done, foreign imports conld be rationed accordingly. The same principle could be adopted in regard to supplies from Canada and other parts of the Empire. The only cure for over-production was to parcel out trade well ahead by definite agreements. He believed that such agreements would soon be as inevitable between nations as they were already between individuals.—(*Times*, 13-12-33).

A RIGHT WOOD FOR EVERY NEED.

The winter course of lectures arranged jointly by the Timber Trade Technical Education Committee and the Timber Advisory Committee of the City of London College opened on Wednesday evening, and it was unique in the sense that it was not confined to timber students. In view of the importance of the subject—" Timber *v.* Its Substitutes " —invitations to the lecture were extended not only to members of the timber trade but to architects, builders and timber users in various industries. In effect the lecture marked the first great effort in the campaign of the Publicity Committee of the Timber Trades Federation to broadcast the virtues of wood and stimulate a wider appreciation of its value and service to mankind.

Upwards of 300 persons assembled in the Pillar Hall of Southern House, Cannon Street, to hear the lecture, which was given by Mr. W. O. Woodward, of Nottingham, chairman of the Sawmilling and Woodworking Section of the Federation.

Mr. Woodward began his lecture on a very happy note—the pleasure that wood provides. From the quotation, " Go up to the mountain and bring wood and build the house, and I will take pleasure in it " (Haggai, B.C. 520), he passed to the observation that everyone loved wood in some form or another. It was an old and trusted friend ; it might be a pipe, a favourite walking-stick, the handle of some tool or instrument, a tennis racket, a cricket bat, or, more frequently, some object that one had carved or made out of wood with one's own hands.

Wood, said the lecturer, permits of flexibility of design to meet individual tastes. It combines strength and stiffness with lightness. It has enormous insulating value, resisting both heat and cold, and has a high degree of immunity from sound—important factors in buildings of all descriptions.

Weight for weight it is stronger than steel. It is resilient and shock absorbing. It is easily sawn, carved or planed to any desired pattern ; it may be bent or twisted, and is readily shaved to paper-like veneers or plywood. It can be quickly and firmly nailed, joined, dowelled or glued into place.

Wood has beautiful natural textures, grains and figures. Its colour is varied and pleasing ; it may easily be stained and painted, thus affording much variety of appearance from a single species. Wood cannot be imitated. It can almost be said that no two pieces are exactly alike.

It is a material which varies greatly according to the zone in which it is grown, or to the nature of the ground, or to various climatic conditions. It is not uniform like metal. There is a right wood for every need and ample supplies, both for new uses and for old ones. Bad wood requires a substitute, and that substitute is usually good wood, and it is the duty of the timber merchant to help the user of wood with the knowledge and experience he has acquired.

At the moment wood is under a cloud. Why? It suffers in common with the small boy and the domestic cat, said Mr. Woodward; it is blamed for many things it has *not* done. Both wood and concrete have been in use for thousands of years, but with this difference. Concrete is now more scientifically used, while wood is less so. More use must be made of the Government Research Station at Princes Risborough, which is always at the service of the community, with its remarkable store of scientific knowledge. This is a point to which great attention must be paid.

Wrong grades and species of wood are being specified: wrong construction is being employed. Wood is being badly treated by the architect, the builder and the timber merchant. Never before have the various fungi and the insects which attack timber had such a wonderful time, or enjoyed so much publicity. Properly used, wood is the finest construction material in the world.

Bad timber has many defects. So have other building materials. Bricks perish and are affected by climatic conditions. They are subject to efforescence—soluble materials left in the brick during baking become dissolved by rainwater, and when this dries out, it leaves a deposit of white crystals on the surface. Brick-work has no strength in tension, and has not resistance to pressures tending to bend a wall inward or outward. Stone crumbles by the action of frost, salt sea breezes and the presence of smoke acids in the air. There is also a disease which attacks stone, the germs of which are known as "nitrifying bacteria." Stone, having no flexibility, will crack if settlement occurs. Concrete is liable to become friable after a time. The exposed surface becomes dehydrated up to a depth of about one inch under quite ordinary conditions, and obscure chemical and physical causes often lead to its collapse. Steel definitely loses strength over a period of years; the strength of girders in the British Museum has already caused uneasiness and they have had to be reinforced. Rubber perishes, iron rusts. Study any ancient building, said the lecturer, and notice the condition of barred windows, the hinges and bolts rusted away on old doors, the perished stone carvings—on the House of Commons, for example.

Fire is the great bogey of wood construction. Yet wood can be made fireproof and some species of wood are naturally fire-resisting. The L. C. C. issue a list of Empire grown hardwoods which may be used as fire-resisting material. A solidly constructed hardwood door, provided that the fit is perfect, is the best fire-proof door known. A pamphlet issued by the British Fire Prevention Committee proves that a floor constructed of solid wood beams is fire-proof. The flames in a very severe test charred the underside of the floor to a depth of less than 2 in.

Of all fires two-thirds of the fire loss is in terms of contents, not buildings. Not more than two or three fires in a hundred are communicated to buildings from out-

side. In an ordinary well-built house, if the joists are strong, the boards grooved and some light pugging used, if the doors are well fitted and fairly strong, a very considerable amount of furniture and fittings can remain well alight for half an hour before there is any spread.

Iron and steel, although incombustible, are not fire-resisting. Steelwork will fail, buckle or bend under its load when raised to a light red heat. Cast iron is apt to break in two under the influence of fire, especially on the application of water.

Mr. Woodward dealt at some length with timber for construction, and mentioned the prophecy of a well-known Chicago architect that there is going to be a great change in the style and types of buildings. Concrete may be obsolete very soon, said the architect, and he visualised the possibility that for outside walls two layers of treated wood may be used, insulated and protected by paint with a total thickness of three or four inches ; while the inside partitions and floors would also be of treated wood, with some method of insulated construction.

A committee of architects, builders, and timber merchants under the ægis of the British Standards Institution were not preparing new standard specifications for timber, and when these were ready, a very definite forward step would have been made in promoting the use of more suitable grades of wood in all building construction.

Too often the services of the architect are dispensed with, the builder being his own architect, and he chooses the cheapest possible grades of timber. Yet a few more pounds spent on better wood would greatly increase the selling value of his house and amply repay his outlay. There is a wonderful opening for the architect in co-operation with the speculative builder who will concentrate on the erection of a small house with more attention paid to interior fitments—hardwood floors, panelled walls, fitted-in cupboards, dressing-tables, washstands, etc., as advocated in recent B. B. C. talks.

Having dealt with the economics of timber-framed schools as advocated in a Board of Education circular last year, the lecturer made some striking observations on windows, doors and flooring. In 1928, 2,000 steel casements were removed from a hotel in Kansas City and replaced by wood, after only two years' use. The same story, he said, could be told over and over again in the United States, Canada, and in England. The steel sash jammed, the hinges twisted, and the repair bill was enormous. Objections to metal casements might be summarised as follows :—They were noisy, expensive to repair, more costly to glaze and to reglaze when broken. When closed, they conducted the warmth into the room in summer and the cold in winter. Metal contracted with the cold, so that the colder the day the greater the contraction, with a consequential leakage of cold air into the room. In case of fire, glass expanded and broke regardless of the material in which it was set. This glass breakage was aided by the rapid expansion of metal sash material, as well as by its buckling. Wood does not hold glass so tightly, permitting expansion without breakage, and does not twist or expand appreciably under heat.

Wooden windows are less costly, but if the same outlay was made on the wooden article as on the metal one, a still higher degree of perfection would be achieved.

The double hung window permits of maximum ventilation, an opening at the top for escape of heated air and an opening at the bottom for intake of fresh air.

With the exception of plywood doors, of which there are numerous beautiful examples, we have drifted largely into the habit of using a standardised door, went on Mr. Woodward. There is far too much sameness in the cottage doors used to-day. Thirty years ago better doors were used. There is no substitute for a wooden door, but there is room for more imagination in the minds of architects for a greater variety in design and a better opportunity thus afforded to the craftsman. There is both laziness and childishness in using always the ready-made article.

Of concrete floors, the lecturer said: They are cold, non-resilient, they tread to dust, which irritates the nose, throat and lungs. They are harmful to the bearings of machinery, difficult to repair, difficult to attach to machinery or for cutting away for pipes, wires, or shafting. They wear unevenly and, if overloaded, this fact is not easily detected.

It is false economy to have a floor laid of cheap or inferior wood. This is especially true of softwoods. Only the best grades should be used, but greater use might be made of white deal for flooring, especially for upstairs rooms.

The floor is the decorative background of the home, and more thought should be given to flooring when building a house. House owners who would save 5s. on the cost of a floor for one room will, subsequently spend pounds on linoleum. An enormous saving can be effected by leaving the surface uncovered by carpets, etc. There is an infinite choice of woods for flooring in species, textures, and colours; and, apart from natural colours, staining has reached a high degree of perfection. There are numerous examples of wood floors which have been in constant service for over two hundred years.

Many failures in floors and in panelling are due to the fact that dry wood is frequently used before the wet plaster has dried out. Dry rot and trouble with insects he did not propose to deal with, but in 90 per cent. of cases they were caused by faulty construction or improperly seasoned wood. There were definite cures and preventatives for both.

Furniture, he continued, was suffering a temporary set-back owing to a wave of "metallic modernism" which it was hardly necessary to take seriously. Any lightly clad damsel who had sat on a metal chair on a very hot or very cold day would gladly exchange it for one of wood. The wooden bedstead had ousted the one of brass. The wooden filing cabinet was definitely safer than the steel cabinet in case of fire. There were actually advocates of the metal coffin. "Nobody had ever tested one of these and lived to record his impression," declared Mr. Woodward, "but there are cemeteries in England which decline to allow their use, and some religious sects also forbid them."

Turning to wood for other uses, he said that engineers specified the materials with which they were most familiar in consequence wood was often overlooked. The vat or tank is a case in point. Wood tanks offered distinct advantages for storing

liquids where temperature changes were important, since the flow of heat through the tank walls was much slower than with other materials used for the purpose. This would decrease evaporation losses and lessen the chance of the contents reaching ignition temperature.

If a tank was to contain liquids which were readily ignited, or which gave off explosive gases, wood had the advantage that it did not give off sparks when struck by hard objects. Wood had these advantages: it was light, strong, economical, durable, impermeable, had low heat conductivity, acid resistance, and was easily worked. No other material had these properties. Furthermore, chlorine and almost any bleaching agent would readily attack most metal.

Concrete fencing is another case. A concrete post was three times the weight of a deal post —a very material factor, both for transport and for erection in country districts. These posts were durable, but not so the wires that connected them up and took the place of the rails. A broken strand of wire affected many bays of fencing until it had been repaired or replaced. It was not unclimbable—in fact, it was the reverse. A broken post cannot be repaired. The use of metal sheets in place of wood for hoardings is now discontinued, as the metal affected the colours of the posters.

Mr. Woodward also spoke of sleepers. The report of the Chief Maintenance Engineer of one of the largest railways in the world, he said, is as follows:—" The wooden sleeper is light in weight, it is cheap, easy to handle, and the track fastenings can be applied to it conveniently. It is a non-conductor of electricity, neither brine nor the elements affect it corrosively, and there is sufficient resilience to absorb the shock of the rolling loads. Steel and concrete sleepers are still very much in the experimental stage; there are many difficulties which must be overcome before they may compete with our present type of construction."

He referred also to a trestle viaduct, six miles long, constructed entirely of creosoted wood which had been in use on the Southern Railway in the U. S. A. for forty-five years: to the statement last month of the Borough Surveyor of Lowestoft that pitchpine piles in alluvial mud were better than concrete, and that there were some jarrah piles that were as good as on the day they were put in; and said that wood block paving had been in use subject to heavy traffic for more than 50 years. For heavy traffic wood block paving is the most economical, being actually cheaper per yard super per annum than asphalt, macadam, or fine dressed granite sett paving.

" To summarise some of my statements," he added, " I would advocate more care in the seasoning of wood, more care in the supply of the right wood for the right job, greater encouragement to the craftsman and a better knowledge of wood's possibilities and capabilities in the minds of architects, engineers, and the general public."

The lecturer showed numerous slides illustrating various points in his remarks, and contrasting the uses of timber products with other manufactures. Included among them was the effect of fire and frost on metal windows compared with wooden framework: concrete and wooden fences: timber schools: workmen's cottages in a suburb of Sweden and in London (the latter having stood the ravages

of time for several centuries). He illustrated how wood had been reinforced by means of the Schüller split-ring dowel, which increased the strength from four to eight times, and gave examples of buildings made on re-inforced wood methods. Following this, a timber film was shown of the creosoting of telegraph poles, which had been provided by the British Wood Preserving Association.

Mr. E. P. Tetsall (ex-president of the Federation) proposed a hearty vote of thanks to Mr. Woodward. One wondered, he said, after such a lecture, whether any doubting Thomases were left regarding the possibility and need of a publicity campaign. Any money put up for such a purpose would be repaid a hundred-fold. He had been particularly interested to come that evening because he hoped to hear something about substitutes; but Mr. Woodward had really shown that there were no substitutes. If anyone wanted to see the effects which could be produced by wood, the finest model in the world, perhaps, was the Stockholm Town Hall, where there was some wonderful decorative work. He had seen wooden buildings in all parts of the world—in Sweden, Russia and the beautiful buildings erected on the west coast of America. There were no nicer houses to live in than wooden ones, and the people attending the next Royal Show to be held at Ipswich would be able to see for themselves what could be done with wooden buildings.—(*Timber Trades Journal*, 7-10-33).

TIMBER USED IN CARRIAGE AND WAGON SHOPS IN INDIA DURING 1932-33.

Analysis of returns showing quantities of various timbers used.

It is strongly recommended that the Trade Names (Col. 2), approved by the Empire Forestry Association, be used in contract and tender forms.

Item No.	Trade Name.	Botanical Name.	Quantity Tons, log. 1929-30	1930-31	1931-32	1932-33.	Remarks.
1	2	3	4	5	6	7	8
1	Teak (Burma)	Tectona grandis	28,292	21,500	11,563	10,070	Recommended that a proportion of high class squares should be purchased and kept separate for bottom sides only. For other purposes, a trial of log ends is suggested. Scantlings are available at favourable rates in Bombay and Calcutta.
2	Teak (Indian)	Do.	5,289	3,842	3,599	2,688	Carriage constructed in 1928 of C. P. teak reported satisfactory.
3	Sal	Shorea robusta	3,092	1,315	2,075	2,109	
4	Deodar	Cedrus deodara	1,940	2,150	1,251	1,630	
5	Padauk (Andaman)	Pterocarpus dalbergioides	1,379	1,611	537	988	Quoted in Calcutta in October 1933 at about Rs. 100 per ton C. I. F.
	„ (Burma)	Pterocarpus macrocarpus	..	..	25	143	
6	*Bonsum	Phoebe hainesiana	500	356	25	205	Often sold as Assam teak. It is not teak and should be ordered as bonsum.
7	Maiyang or eng	Dipterocarpus tuberculatus.	433	1,339	1,398	1,011	Maiyang is the Siamese name for the timber called eng in Burma.
8	*Hollong	Dipterocarpus pilosus	..	..	..	427	
9	*Gurjan	Dipterocarpus turbinatus and allied species.	348	652	37	60	Similar to eng or maiyang and sometimes substituted. See item 42.
10	*Haldu	Adina cordifolia	515	866	1,015	667	
11	Jaman	Eugenia jambolana	..	405	399	109	Also called nerale. Used for bottom boards.
12	Poon	Calophyllum species	142	562	315	288	Sawn veneers are better than rotary cut veneers, which are apt to develop hair cracks. Available in S. India in very large sizes and good for bottom boards.
13	Shisham	Dalbergia sissoo	116	239	160	175	Used for dining car furniture.
14	Indian rosewood	Dalbergia latifolia	..	..	2	6	
15	Laurel	Terminalia tomentosa	19	623	1,041	251	Also called asna, taukkyan, saj and matti. Used for bottom boards. See item 42.
16	Kindal	Terminalia paniculata	..	84	159	147	Also called honal.

Item No.	Trade Name.	Botanical Name.	Quantity, Tons, log. 1929-30	1930-31	1931-32	1932-33.	Remarks.
1	2	3	4	5	6	7	8
17	Badam	.. Terminalia procera	111	50	59	320	From Andamans. Available in large quantities.
18	White chuglam	.. Terminalia bialata ..	19	14	4	..	From Andamans, available in large quantities.
19	*Hollock	.. Terminalia myriocarpa	..	26	200	282	From Assam, available in large quantities.
20	Benteak	.. Lagerstrœmia lanceolata	74	325	377	296	Also called nara.
21	*Tavoy wood	.. Parashorea stellata	..	412	251	25	Should not be used in exposed situations.
22	*Ramdala (lampatti)	Duabanga sonneratioides	5	230	27	213	An excellent timber for all general purposes. Does not warp or split and not prone to movement when seasoned.
23	Chaplash	.. Artocarpus chaplasha	..	173	22	..	Suitable for interior and ornamental work. A sound wood.
24	*Cham	.. Michelia champaca	3	132	..	62	A sound medium weight wood. Very durable under cover. Used for panelling and furniture.
25	*Jarul or pyinma	Lagerstrœmia flos-reginæ	88	170	382	65	Andaman pyinma is *Lagerstrœmia hypoleuca*, light and strong.
26	*Toon	.. Cedrela species ..	18	92	106	69	
27	Irul	.. Xylia dolabriformis	..	32	20	35	Hard, but very durable even out of doors. Rather difficult to work.
28	Bija sal	.. Pterocarpus marsupium	340	372	233	195	Durable and handsome. One of the padauk family and well known as a fine timber, also called honné.
29	Babul	.. Acacia arabica ..	93	67	47	59	Chiefly for keys. Very durable. Satisfactory for carriage doors and side pillars.
30	*Thingan	.. Hopea odorata ..	..	76	287	3	A very good strong timber for constructional work. Deserves attention.
31	Dhaman	.. Grewia tiliæfolia ..	..	12	86	46	A good tool handle wood. Also called thadsal.
32	Jack	.. Artocarpus integrifolia	..	13	9	..	Well known as an excellent furniture wood. Has been exported to Europe for furniture. Also called hebblesu.
33	*Yon	.. Anogeissus acuminata	..	6	253	105	Inclined to warp and twist even when kiln seasoned. Specially suitable for hammer shafts (see page 7, paragraph 4).

* Species included among those selected for the kiln seasoning experiment at Lillooah, East Indian Railway.

Item No.	Trade Name.	Botanical Name.	Quantity, Tons, log. 1929-30	1930-31	1931-32	1932-33.	Remarks.
1	2	3	4	5	6	7	8
34	Semal	.. Bombax malabaricum	26	32	23	20	A very light wood. Useful *for dust shields for axle* boxes.
35	Amoora	.. Amoora wallichii ..	1	7	4	200	Also called white cedar.
36	Chikrassy	.. Chikrassia tabularis	..	..	14	20	Figured logs obtainable from Burma in fair quantities. The wood of these logs, quarter-sawn, is very handsome.
37	Aini	.. Artocarpus hirsuta ..	97	7	32	24	Its density varies considerably and it is apt to have a woolly texture. It is durable but its former reputation is rather inflated.
38	Vellapiney (belapine)	Vateria indica ..	47	4	..	..	Not recommended. Also called piney maram.
39	Kolavu	.. Hardwickia pinnata	..	..	150	123	
40	*Malabar junglewood	Mixed species ..	375	296	344	478	
41	*Miscellaneous hardwoods and junglewoods.	....	†3,100	1,669	479	289	
42	Mixed scantlings	....	..	..	270	‡2,032	
		Foreign Imported Timbers.					
43	Hickory	.. Hicoria species ..	39	14	53	11	
44	Red lauan	.. Shorea negrœnsis and other species.	..	147	..	..	From Philippines and British North Borneo. Not recommended. Logs crack badly in sun.
45	White lauan	.. Shorea mindanensis and eximia.	..	50	..	..	
46	Golden teak	.. Tetramerista glabra	..	50	216	..	From Sumatra. Described by Dr. Foxworthy, Timber Research Officer, Philippine Islands :- "The wood will decay if left in contact with the ground; subject to white ant attack. Dries out slowly." It is not teak but is sold in India as "golden teak" and "zaver teak." Not to be confused with genuine teak from Java (Tectona grandis). It has not proved a success in India.

* Nos. 40 and 41. It is requested that as far as possible a record may be kept in future of the species purchased.

† Included considerable quantities of laurel item 13.

‡ Eng or maiyang, asna, haldu, sal and shisham.

REMARKS.

1. (*a*) *Total amount spent on timber, other than sleepers, by Class I Railways.*

	Rs. lakhs.				
1927-28	.. 140·6 including	Rs. 2 lakhs imported timber purchased in India.			
1928-29	.. 96·4	Do.	Rs. 8 lakhs	do.	do.
1929-30	.. 108·7	Do.	Rs. 4·35 lakhs	do.	do.
1930-31	.. 92·30	Do.	Rs. 8 lakhs	do.	do.
1931-32	.. 37·99	Do.	Rs. ·59 lakh	do.	do.
1932-33	.. 14·17	Do.	Rs. ·006 lakh	do.	do.

The progressive drop in expenditure is remarkable and suggests that the time cannot be far distant when circumstances will necessitate increased purchases of timber.

The above figures include expenditure incurred by Burma Railways, whereas the figures in the preceding statements have been confined to railways in India, in order that the totals may be comparable with previous years when the Burma Railways consumption was not included. The 1932-33 figures for Burma Railways were :—

			Tons, log.
Teak, Burma (Tectona grandis) ..	..	..	174
Bijasal (Pterocarpus marsupium)	..	..	165
Padauk (Pterocarpus macrocarpus)	..	..	5
Haldu (Adina cordifolia) ..	..	..	20
	Total	..	364

(*b*) *Total amount of timber consumed in Carriage and Wagon Shops.*

	Tons, log.		Percentage of total.	
			Burma Teak	Indian Teak and Indigenous Timbers
1927-28 ..	34,000	..	69	31
1928-29 ..	Not available	..	..	..
1929-30 ..	45,000	..	57	43
1930-31 ..	42,000	..	50	50
1931-32 ..	29,000	..	40	60
1932-33 ..	28,000	..	36	64

The continued rise in consumption of cheaper timbers is natural during a period when repairs and miscellaneous work so much exceed new construction ; actually 78 per cent. of the timber used was devoted to these purposes. The price of Burma teak squares continued to come down slowly and the average works out to Rs. 225 per ton compared with about Rs. 230 and Rs. 240 during the last two years. Since the close of the financial year, to which the above figures refer, some purchases have been made at considerably lower prices, *e.g.*, in July 1,500 tons Indian first class

squares were obtained at Rs. 147 to Rs. 165 per ton c. i. f. Bombay. Burma teak Boards 9″×5″×1″ and up were bought in Bombay at Rs. 150-8-0 per ton, which compares with Rs. 215 per ton in 1931-32. The teak market generally, both in Burma and Siam, was unprecedentedly dull throughout the year and such recovery as has taken place so far is in respect of low grade squares and scantlings, for the latter of which the demand is steadily increasing owing to the saving in freight and wastage and the advantage of having seasoned material ready for use.

(c) *Total consumption of Indian teak.*

	Tons, log.
1927-28	700 (2 per cent. of grand total).
1929-30	5,300 (12 do. do.).
1930-31	4,000 (10 do. do.).
1931-32	3,600 (12 do. do.).
1932-33	2,800 (10 do. do.).

The proportion of Indian teak used has remained fairly constant for four years. Malabar teak, which is available in long lengths and large sizes, is recommended for bottom sides as its oily nature should render it more immune from attack by fungus or white ants than any other timber owing to the antiseptic properties of the oil.

The price of C. P. teak floor boards, referred to last year as being high at Rs. 238 per ton, fell remarkably to about Rs. 75 per ton in July 1933, due to intense competition with floor boards of sal.

(d) *Total consumption of indigenous timbers, other than teak.*

	Tons, log.
1927-28	9,800 (29 per cent. of grand total).
1929-30	14,200 (31 do. do.).
1930-31	17,000 (40 do. do.).
1931-32	14,000 (48 do. do.).
1932-33	15,000 (54 do. do.).

(e) *The total timber used was divided up as follows :—*

	New Construction.	Repairs and Miscellaneous.
	Per cent.	Per cent.
1927-28	42	58
1929-30	38	62
1930-31	33	67
1931-32	31	69
1932-33	22	78

INDIAN FORESTER,

APRIL, 1934.

LIFE IN FOREST SOILS.

The study of the living organisms of the soil has been brought into the limelight with the recent award of a Paris Academy of Sciences prize to S. Winogradsky for his work on the microbiology of the soil. Until a few years ago this study was known as bacteriology but as the bacteria formed only a section of the living forms which occur in the ground this more general term has since been accepted. We have frequently commented upon how little the average forester knows about the soil in which his trees grow, and this is particularly the case as regards the effect of soil micro-organisms upon its fertility.

Possibly the best general survey of the subject is S. A. Waksman's *Principles of Soil Microbiology*, the second edition of which has recently been published by Baillière Tindall & Cox of London (52/6 nett). This is a rather alarming and formidable tome whose appearance is calculated to discourage all but the stoutest-hearted seekers after knowledge, but there is nevertheless much that is of vital interest in it to all growers of plants. It summarises all that is known of the soil population, and describes the often very indirect methods by which research workers have arrived at figures of the relative numbers of bacteria, fungi, algae, and protozoa. It then devotes a good deal of space to an analysis of the different kinds of soil bacteria which are classified as follows :—

Classification of soil bacteria based upon their physiological activities.

I. *Autotrophic* (independent): capable of obtaining their carbon from the CO_2 of the atmosphere and their energy from the oxidation of inorganic substances such as nitrogen and other mineral compounds in the soil. These are further sub-divided according to

whether they use nitrogen, sulphur, iron, or simple carbon compounds, or hydrogen as a source of energy. This group does not need any organic nutrients and is incapable of decomposing humus.

II. *Heterotrophic* (dependent on a saprophytic partnership) deriving their carbon and energy from various organic compounds. There are two groups :—

1. Nitrogen-fixing bacteria, deriving their nitrogen from the atmosphere in the form of gaseous atmospheric nitrogen.

2. Those requiring compound nitrogen. This group is again sub-divided in (*a*) aerobic (requiring free oxygen) and (*b*) anaerobic (capable of developing in the absence of oxygen), though the difference between these is largely one of degree and they cannot be separated entirely.

We thus see that bacteria are nature's method of manufacturing her vital requirements of nitrogen from air and from the minerals and vegetable deposits of the soil. When it is remembered that the nitrogen demands of growing trees to make their timber and leaves may be as much as 50 pounds of nitrogen per acre per year, and that a shortage is disastrous to almost all types of plant growth, the laboratory of the soil can safely be recognised as nature's "key industry."

The third and fourth parts of Waksman's book contain a discussion of the chemical reactions in which these various bacteria and other organisms take part. A knowledge of their nutrition and requirements is essential to a full understanding of the biochemical processes of soil improvement and degradation, but the processes of decomposition of hydrocarbons and synthesis of proteins are exceedingly complex and in a constant state of flux, so that the ebb and flow in the tide of fertility can, as a rule, only be guessed at from the demonstrable effects upon the growing plants. This is particularly the case in forest soils, for up to date the microbiologists have concentrated upon agricultural soils which are under intensive cultivation, and our knowledge of forest soil metabolism is very limited. Early workers such as Ramann and Muller considered fungi to be the only agents in the development of the soil from the raw plant remains of

the forest floor, but it has since been shown that in the later stages at any rate bacteria are also of great importance, and in the tropics at least termites do a large share in breaking down complex chemical remains, while the deep and friable mull soil of deciduous forests is largely the result of the activity of earthworms. The importance of the rôle of protozoa (unicellular animal organisms) has been proved by Sir E. J. Russell and other workers at Rothamsted; by treating the soil with heat or disinfectants which could not in themselves destroy the bacterial population, they proved that soil protozoa, by using the bacteria as food, themselves limit bacterial activities in the soil and also therefore limit soil fertility. By heating the soil the protozoa are destroyed but the bacteria remain alive and multiply more rapidly than before, their increased activities resulting in a greater liberation of nitrogen and an increase in plant growth. This gives a logical explanation of the remarkable temporary fertility of burnt seedbeds. It must not be thought however that protozoa are wholly injurious. By destroying excess bacteria the protozoa may stimulate further bacterial development and therefore further biological changes in the soil. Protozoa also take part in certain soil processes such as the decomposition of cellulose and are found in the intestinal tract of termites fulfilling this rôle; without them termites cannot live on a wood diet.

The Forest Research Station at Sopron in Hungary has just published a summary of 10 years' work on this subject (*Untersuchungen über die Mikrobiologie des Waldbodens*, by Dr. D. Fehér, published by J. Springer, Berlin, price Reichmarks 24) and this appears to be the first sustained attempt to deal with the question from the foresters' point of view. A great deal of valuable information has been collected about the activities of each type of organism in a large variety of forest sites between latitudes 46° and 70° in Europe, and the main conclusion arrived at is that a marked seasonal development follows very closely the increase in the energy of summer sunlight, which is the dominating factor in practically all the life processes of the soil. Only in extreme cases such as under desert conditions does the high temperature of the soil in summer have any checking effect

upon these activities. These conclusions are for central European conditions and it should be of very vital interest to know just how far the same can be applied to our tropical and semi-tropical Indian forests.

Professor Fehér has now extended his researches to the forest soils of other continents and a first consignment of samples of soils from the Dehra Dun forests has recently been despatched to him in sealed bottles. Even with careful packing however it is highly improbable that such delicate organisms as oxygen-loving bacteria can survive a month's travel in a sealed receptacle and it is essential that we should have some arrangements for such soil studies as part of our own organisation rather than depend upon the rapidly growing interest in this subject abroad.

ON A BOTANICAL VISIT TO MULAYIT PEAK, WITH A SKETCH OF THE VEGETATION OF THE TENASSERIM HILLTOPS.

By C. E. Parkinson, Forest Botanist, F.R.I.

The southern continuation of the mountains of the Shan plateau and of Martaban form the Tenasserim Yomas, a chain of hills running almost due south from the Thaungyin river and the Salween near Moulmein through the Amherst, Tavoy and Mergui districts to Victoria Point. These hills average about 3,500 feet in height and are covered nearly everywhere with dense forests interesting both on account of their flora and fauna. The outstanding peaks are the Mela-taung, 6,342 feet, and Mulayit, 6,821 feet, in the Dawna hills—the name given to the northern end of the Tenasserim Yomas in the Amherst district—and further south Nwalabo, 4,989 feet. in the Tavoy district, and Myinmolekat, 6,852 feet, about 70 miles north-east of Mergui.

Mulayit peak lies some 62 miles distant, as the crow flies, east-south-east from Moulmein. It is visible and easily recognised from the plains below and from the Ta-ok plateau on account of its height and sharp profile. It is best approached from Kawkareik, a small

town a few hours' journey from Moulmein, from where there is a fair weather cart-track to Kyeikywa, 35 miles, the most convenient starting off place for the peak. From Kyeikywa Mulayit is some 15 miles distant according to the map, but it will seem, and probably is, easily double that distance on foot.

The writer's visit was in the nature of a botanical trip in the course of a tour from Ye, on the Amherst coast, across country to Kawkareik. Elephant transport was used on the tour and the going was rough in places but even this mode of travel is hardly possible much beyond Kyeikywa where all the heavier baggage was left. The elephants were actually taken with very light loads as far as Kawpadokhi, a small Karen hamlet of about three or four houses on the way to Mulayit, where water and grazing is plentiful.

There was some difficulty about obtaining coolies at Kyeikywa for nobody seemed to share the writer's enthusiasm about the projected visit to the peak, but seven were eventually obtained and this number supplemented by three more from Kawpadokhi. Only the barest necessities were taken, a ground sheet and a small servant's pal for sleeping in, a roll of bedding containing necessary clothing and sufficient food for 4 or 5 days. Botanical presses and drying papers formed perhaps the largest item of the baggage.

From Kawpadokhi the path follows the ridge running nearly north-east between the Kyeik and the Mikalaung chaungs. Early on this march some interesting bamboo forests were passed through where *Gigantochloa macrostachya* was found growing almost pure and single-stemmed, an uncommon mode of growth for this bamboo, and the large bamboo *Dendrocalamus brandisii* was common. It was most probably here that Beddome gathered the specimens which Gamble referred to *D. flagellifer* Munro and which are probably only the commoner species *D. brandisii.* Further up along the ridge the forest was drier, with *Dendrocalamus strictus* and scrub and even almost bare in places, but the slopes of the hills opposite and the valleys were well clothed with dense jungle. After more or less continuous going from early morning with occasional halts by the way to gather botanical specimens the first camping site was reached at

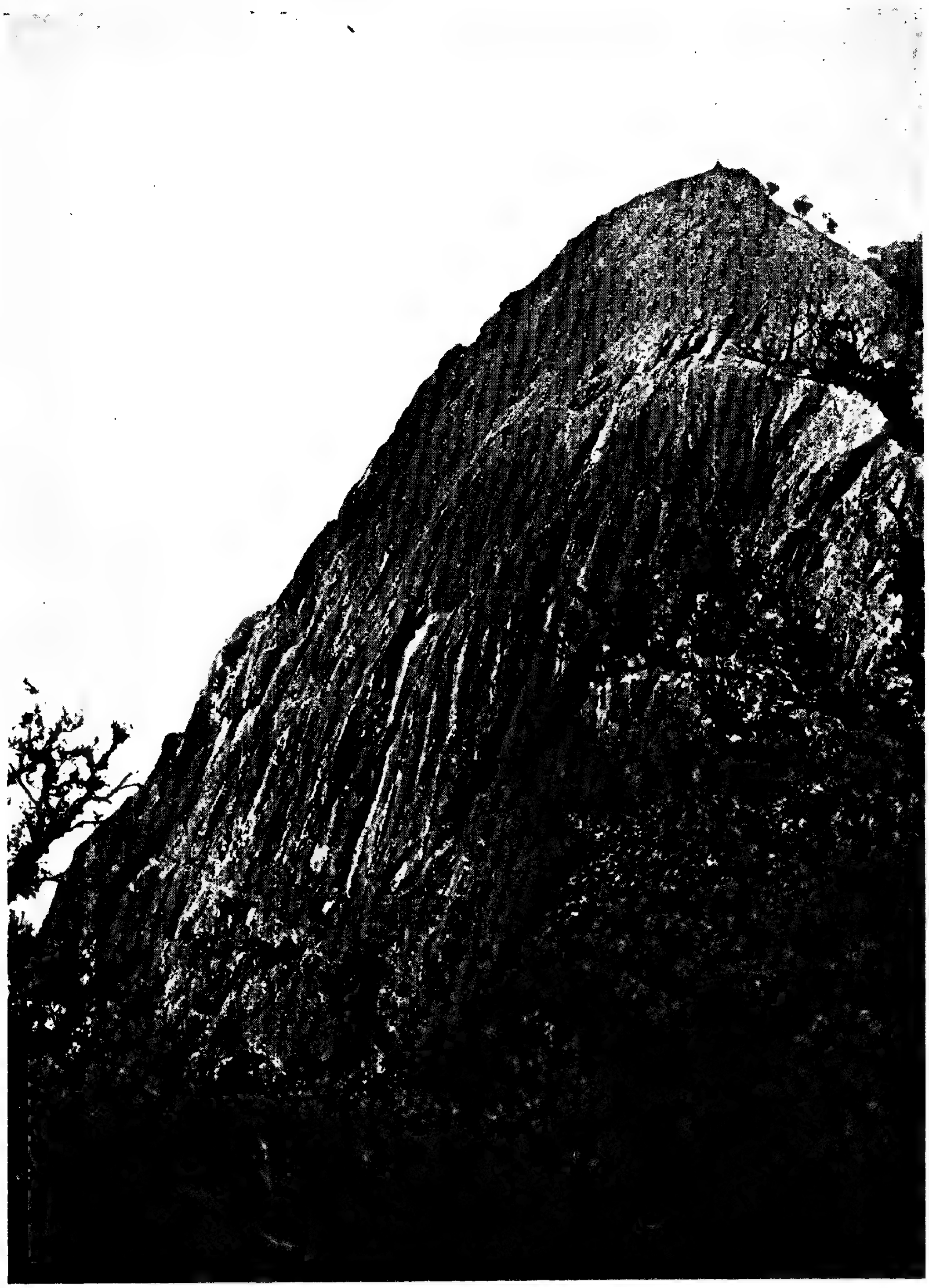
about 2 in the afternoon. This was a little beyond the 4,180 feet survey mark and was a necessary halting place for the night as the coolies said that the next camping site could not be reached before nightfall.

An early start was made next morning and at about 4,500 feet some very interesting forests were passed through. *Sloanea sigun, Manglietia utilis, Schima noronhae* and *Acer isolobum* were seen, with *Sapria himalayana* parasitic on the roots of some of these trees: surely this must be the "Rafflesia" recorded by Theobald and referred to by Sir J. D. Hooker in his sketch of the Flora of British India (1906), p. 51, from the Ta-ok pass!

The patch of small reed-like bamboo, *Arundinaria gallatlyi*, was seen at about 5,500 feet where Gallatly most probably collected it on his trip up to Mulayit just fifty years previously in 1877. This was fortunately found in flower and specimens were taken.

Some four miles below the peak a good spring was found and beyond this the path went up some terraced boulders where going was necessarily slow: some interesting *Vacciniums* and *Agapetes* were found as well as Lace's *Ardisia gracilis* and the epiphyte *Rhododendron veitchii*, conspicuous when in flower and looking like an orchid among the branches of trees.

An open *kwin* (grassy plain) some 4 or 500 feet below the peak was reached at about 3 in the afternoon and, as water was available near by, camp was pitched within view of the summit. In the evening the writer wandered about the open hillsides where the grass *Arundinella setosa* is quite common and a stunted oak, *Quercus sumorpha*, and some *Rhododendrons*, *R. formosum*, *R. parishii* and *R. moulmainense* occur. On these some uncommon orchids were found including *Cirrhopetalum retusiusculum*, recorded from Mulayit in the Flora of British India, and *Bulbophyllum lemniscatum*, two gems small enough to fit in the palm of the hand, the latter having a spike of flowers looking like a pink caterpillar. As the writer strolled about a herd of bison were disturbed and scampered off at break-neck speed down the hillside.



Mulayit Peak, looking west. Note the pagoda on the summit.

Photo:—C. E. P.

Early next morning the whole party set off for the summit which was reached at about 8 a.m. The approach to it is from the north along a sharp ridge where *Rhododendron arboreum*, growing perhaps at its very south-eastern limit, was found. The final ascent is made easier by a roughly stepped path cut along the hillside for pilgrims, for some sanctity attaches to the shrine on this outstanding peak in the wilderness; an excellent view of the surrounding country is obtained and one can see far into the hills of Siam in the east and across the plains of the Haungtharaw valley and the Taungnyo-Kyaikkami hills to the west into the dim distance beyond. The hillsides for miles around the peak are covered with dense forests and our camp on the *kwin* just below the peak was clearly visible. The writer could hardly bear to look over the steep bare granitic southern face without some feeling of insecurity about the head and legs: this face falls at an angle of about 60 degrees or more and appears, as steep slopes often do, much steeper than they really are especially when looked over into apparent nothingness below, for the convexity of this face hides the nearer slopes from view and one only sees the distant slopes at great depth below.

On the summit were the remains of an old shrine which Tickell saw there in 1855 and which must have been erected at considerable cost and energy. The labour entailed in carrying this material up the mountain was probably voluntary and in the nature of an offering organised by a holy *hpongyi* (Burmese monk) about whom the local villagers tell a reverent tale. A bell of no small weight, some ornamental carvings and bricks and boulders lay strewn about and alongside a new *pagoda* had been recently erected, a temporary structure built of tiers of bamboo basket-work filled with earth. It had been bent over by the force of the strong winds that must blow up here. The Buddhist members of the party knelt at the shrine and prayed devoutly while the writer rested and viewed the surrounding country; some specimens which were found growing on the summit were collected, *Ainsleia pteropoda* and *Senecio kurzii*, identical with those collected on this summit by Parish in 1868.

It was with some slight regret that the peak was left, and the descent once started was rapid and camp was soon reached. The party was sent out in various directions to collect orchids and botanical specimens and the writer strolled down the steep eastern ridge towards the Megala chaung from where the accompanying photograph of the peak was taken. The *Peucedanum* which turned out to be an undescribed species was found growing here.

On return to camp in the afternoon a busy evening was spent sorting the material collected, arranging the specimens in the botanical presses and making notes, and this work was carried into the night by the light and warmth of a camp fire. Temporary presses were improvised as those brought were already full to bursting point and baskets were made for carrying down the orchids.

The descent to Kyeikywa was easy and rapid, a night was spent at the half-way camp and Kawpadokhi was reached by noon on the following day.

Mulayit has been occasionally visited by a few forest officers and naturalists. Major S. R. Tickell, then Deputy Commissioner of the Amherst district, visited the peak in February 1855 and again in February 1859. He gives a good account of his visit in the *Journal of the Asiatic Society of Bengal*, Vol. XXVII, No. 5 (1859). He mentions having passed through a "belt of small reed or cane-like bamboo" which, from his location, must be the patch of Gallatly's *Arundinaria*. He also camped on the *kwin* below the peak and describes it as being 6 or 8 acres in extent and covered with a short hard grass (*Arundinella setosa*) and compares it to an open down like a Cumberland "fell." He is much impressed, as the writer was, by the "awful grandeur" of the peak and says that he has been "in the Himala (*sic.*), both at Darjeeling and in Nepal and also on Table Mountain but has seen nothing approaching the tremendous sublimity of this most singular pinnacle." He computed its height to be 7,171 feet by means of an aneroid and by boiling water. He found that two pagodas had been erected on the summit "years ago." He was interested in ornithology and apparently made no botanical collections.

The Rev. C. S. P. Parish, Chaplain of Moulmein, where he lived for about 25 years (1852—1878), visited Mulayit peak on or about the 26th of March 1868. He was an orchidologist and made remarkable collections and drawings of orchids. His botanical collections are chiefly at Kew.

Mr. George Gallatly, a botanical collector from the Royal Botanic Gardens, Calcutta, visited the peak on the 31st of January 1877. His collections are chiefly at Calcutta and at Kew.

Colonel R. H. Beddome, a Conservator of Forests and a botanist, came across from Madras to see the teak forests of Burma and visited the peak in June 1879. His collections are chiefly at Kew and at the herbarium of the British Museum.

Mr. J. H. Lace, Conservator of Forests, whose botanical collections in India range from Baluchistan to Burma, visited the peak on the 27th of January 1912. His collections are chiefly at Kew, Edinburgh and Calcutta.

Thomas Lobb, a collector of Veitch's, visited the Dawna hills in 1847. His collections are at Kew and are frequently referred to in the Flora of British India under the locality Thoung Gain, Thoungyun, Thaung Gyne, etc. Mulayit is also mentioned in that work in connection with the collections of Beddome and Parish by the name Moolee or Mooleyit.

The Ta-ok plateau, about 3,500 feet, lies some 20 miles north of Mulayit. It is a delightful spot with open grassy downs interspersed with evergreen jungle said to be very like the *sholas* of the Nilgiris. It is crossed by a foot-path from Ta-ok village on the Thaungyin side to the Haungtharaw valley. Brandis, who crossed it in April 1859, refers to it as the Donat pass.

The writer has not had the opportunity of visiting the other peaks of the Tenasserim hills but from references in botanical literature and the collections made by other visitors their flora appears to be similar to that found along the Dawna hilltops and around Mulayit. Nwalabo was visited by Mr. C. G. Rogers in January 1909 and by Mr. R. N. Parker in December 1924 and Myinmolekat by Mr. Parker in January 1930.

A sketch of the vegetation of the Tenasserim hilltops.—The vegetation of the Tenasserim hills below the 3,000 or 3,500 foot contour line, the so-called "frost-line," is nearly the same as that commonly found at similar altitudes in Lower Burma, but above this contour it changes and few of the plants found in the lowland forests occur above it. Some families which are well represented below this line in Lower Burma, like the *Dipterocarpaceae* with about 25 species, are altogether unrepresented above it. Few, if any, of the 20 or more species of bamboos commonly occurring in Lower Burma are found above the line; in addition to the few recorded in the list given below *Neohouzeana helferi*, and *Pseudostachyum polymorphum* are likely to occur. *Melocanna bambusoides*, so common on the hills of Arakan, apparently does not occur on the Tenasserim hills. On the other hand some families of plants, like the *Vacciniaceae* and *Ericaceae*, which are poorly or almost unrepresented below this line come into prominence above it.

The following enumeration of plants occurring in the Tenasserim hills, chiefly above the 3,000 foot contour line, has been compiled from the collections referred to above and from the Flora of British India. It is not a complete one but suffices to show the main features of the vegetation of these hilltops. Some plants of the Martaban hills, from Taepo and Nattoung, are included as they are likely to occur in the Tenasserim hills.

MAGNOLIACEAE.

Illicium griffithii Hk. f. and Th. Dawna hills, *Lace*. Nwalabo at 3,500 ft., *Parker*.

Illicium majus Hk. f. and Th. Dawna hills at 3,500 ft., *Lobb*.

Kadsura scandens Blume. Slopes of Mulayit, *Parkinson*.

Manglietia utilis Dandy. Slopes of Mulayit, *Parkinson*. Nwalabo at 3,200 ft., *Parker*.

ANONACEAE.

Ellipeia costata King. Slopes of Mulayit at 5,000 ft. *Gallatly*. Ta-ok plateau, *Lace*.

PITTOSPORACEAE.

Pittosporum ferrugineum Ait. Dawna hills, *Lobb*. Myinmolekat at 6,000 ft., *Parker*.

POLYGALACEAE.

Polygala karensium Kurz. Taepo and Nattoung hills at 5,000 ft. *Brandis, Parish.* Myinmolekat at 6,700 ft., *Parker.*

GUTTIFERAE.

Calophyllum parkeri Fischer. Nwalabo at 3,100 ft., *Parker.*

Calophyllum polyanthum Wall. Dawna hills at 3,000 ft., *Lace, Parkinson.*

TERNSTROEMIACEAE.

Anneslea fragrans Wall. Mulayit, *Gallatly.* Kurz considers the hill form, occurring here and also on the Martaban hills at 6-7,000 ft., with acute leaves and shorter thicker peduncles, as distinct, *A. monticola.*

Camellia drupifera Lour. Dawna hills, *Lace.*

Eurya japonica Thumb. var. *nitida.* Dawna hills at 5,000 ft., *Lobb.* Myinmolekat at 6,500 ft., *Parker.*

Eurya symplocina Blume. Mulayit, *Parkinson.* Nattoung at 7,000 ft., *Kurz.*

Pyrenaria camelliaeflora Kurz. Martaban hills at 4,000 ft., *Brandis.* Mulayit, *Gallatly, Lace.* Dawna hills, *Parkinson.*

Pyrenaria diospyricarpa Kurz. Martaban hills, Doyokee pass at 4,000 ft., *Brandis.* Lomatee, *Gallatly.*

Saurauja roxburghii Wall. Dawna hills at 4,000 ft., *Parish.*

Schima noronhae Reinw. Dawna hills, *Lace, Parkinson.* Nwalabo at 3,500 ft., *Parker.*

Ternstroemia japonica Thumb. Mulayit, *Parish.*

STERCULIACEAE.

Reevesia pubescens Mast. Dawna hills at Misty hollow, *Parkinson.*

TILIACEAE.

Sloanea sigun Blume. Ta-ok plateau, *Brandis.* Dawna hills, *Lace.* Mulayit ridge, *Parkinson.*

Sloanea kerrii Craib. Nwalabo at 3,100 ft., *Parker.*

LINACEAE.

Erythroxylum kunthianum Wall. Dawna hills, *Parish, Lobb, Lace.*

RUTACEAE.

Evodia meliaefolia Benth. Dawna hills, *Maung Ba Pe.*

Evodia pteleaefolia Merrill. (*E. gracilis* Kurz). Martaban hills, Taepo at 3,000 ft., *Brandis.* Dawna hills, *Lace.* Mulayit, *Parish.*

Paramignya monophylla Wight. Dawna hills at 5,000 ft., *Lobb.*

OLACACEAE.

Gomphandra penangiana Wall. Mulayit, *Parkinson.* Dawna hills, *Lobb.*

CELASTRACEAE.

Euonymus fusiformis Parker. Myinmolekat at 4,000 ft., *Parker.*

Microtropis scottii Parker. Myinmolekat at 6,000 ft., *Parker.*

ACERACEAE.

Acer isolobum Kurz. Martaban hills 5-7,000 ft., *Kurz.*

Acer niveum Blume. Slopes of Mulayit, *Parkinson.*

ANACARDIACEAE.

Rhus amherstensis W. W. Smith. Ta-ok plateau, *Lace.*

LEGUMINOSAE. (Papilioneae).

Campylotropis rogersii Schindler. Maungpok-Nwalabo ridge at 3,000 ft., *C. G. Rogers.*

Derris monticola Prain. Nattoung hill, *Kurz.* Slopes of Mulayit, *Parkinson.*

Desmodium prainii Schindler. Mulayit, *Beddome, Gallatly.*

Lespedeza pinetorum Kurz. Mulayit, *Gallatly.*

Millettia puerarioides Prain. Dawna hills at 4,000 ft., *Gallatly.*

Priotropis cytisoides Wight and Arn. Slopes of Mulayit, *Beddome, Parkinson.*

(Caesalpinieae).

Bauhinia kurzii Prain (*B. rosea* Kurz). Taepo at 5,000 ft., *Gallatly.*

Gymnocladus burmanicus Parkinson. Ta-ok plateau at 3,500 ft., *Parkinson.*

Saraca lobbiana Baker. Dawna hills, evergreen lower slopes, *Lobb, Parkinson.*

(Mimoseae).

Acrocarpus fraxinifolius Wight. Dawna hills, evergreen lower slopes, *Lace, Parkinson.*

Pithecolobium clypearia Benth. Dawna hills at 4,000 ft., *Parkinson.* Nwalabo at 3,500 ft., *Parker.*

Pithecolobium montanum Benth. Mulayit, *Beddome.*

ROS CEAE.

Eriobotrya latifolia Hook. f. Dawna hills at 5,000 ft., *Lobb.*

Eriobotrya sp. Myinmolekat at 4,000 ft., *R. N. Parker* No. 3098.

Pyrus cuspidata Bertol. Mulayit, *Beddome, Lace.*

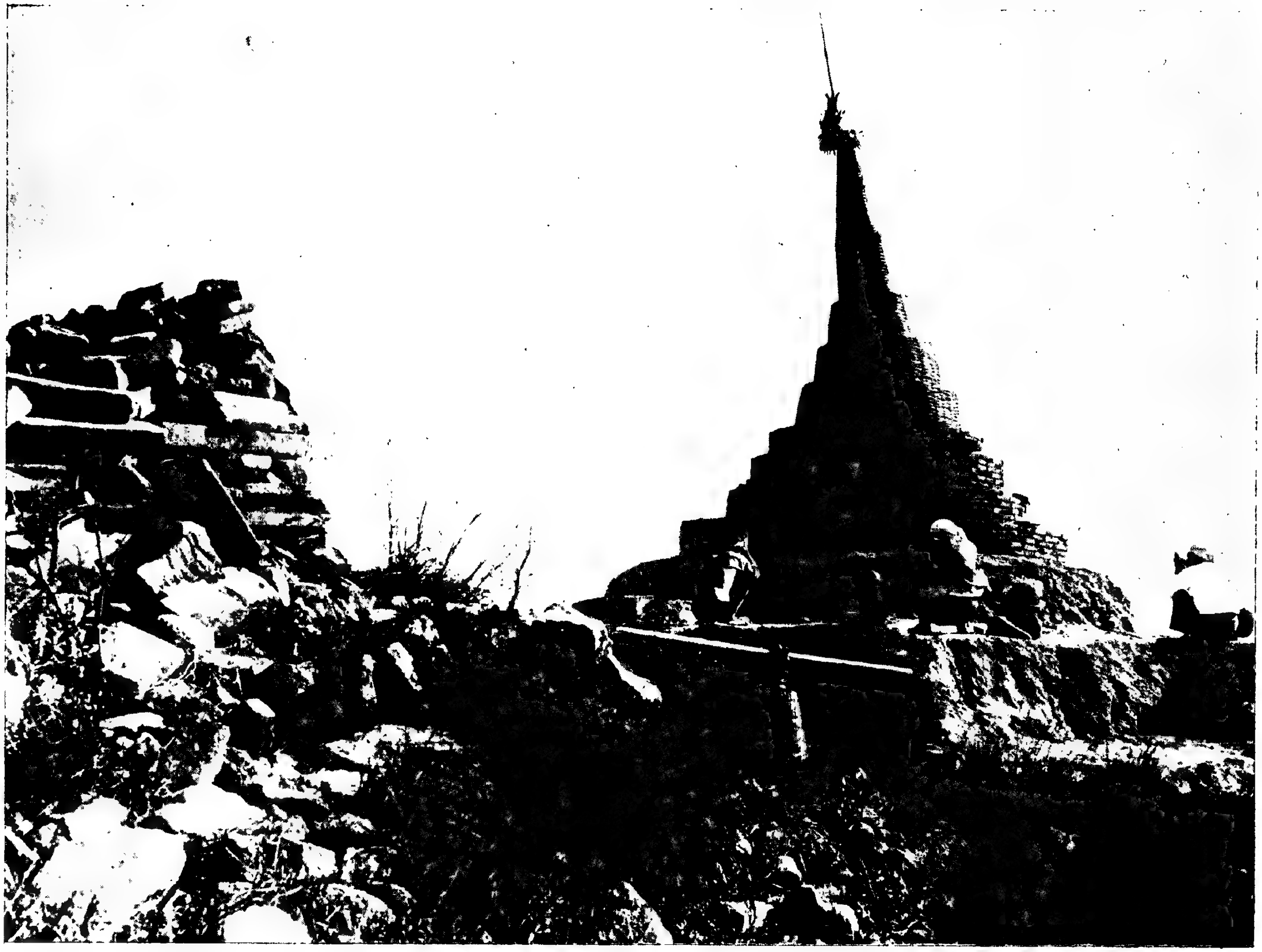
Pyrus granulosa Bertol. Martaban hills at 7,000 ft., *Kurz.* Mulayit, *Parkinson.*

SAXIFRAGACEAE.

Polyosma integrifolia Blume. Dawna hills at 3,500 ft., *Parkinson.* Myinmolekat at 6,500 ft., *Parker.*

MYRTACEAE.

Eugenia smaliana Brandis. Spur to Mulayit at 3,500 ft., *Lace, Parkinson.*



Summit of Mulayit Peak.

Photo :—C. E. P.

Eugenia toddaloides Wight, var. *latifolia* Craib, Spur to Mulayit at 5,000 ft., *Parkinson.*

Eugenia sp. Myinmolekat at 6,000 ft., *R. N. Parker* No. 3106. Small tree common on exposed ridges; the specimens are in fruit and appear to represent an undescribed species.

MELASTOMACEAE.

Melastoma decemfida Roxb. Dawna hills, *Parish, Lace.* Myinmolekat at 6,000 ft., *Parker.*

Osbeckia crinita Benth. Mulayit, *Parish.*

Sonerilla collina Parker. Myinmolekat at 6,000 ft., *Parker.*

Sonerilla sp. Slopes of Mulayit at 4,500 ft., *Parkinson* No. 5122.

BEGONIACEAE.

Begonia dux C. B. Clarke. Mulayit at 5,000 ft., *Parish.*

UMBELLIFERAE.

Peucedanum parkinsonii Fedde. Mulayit at 6,000 ft., *Parkinson.*

CORNACEAE.

Alangium barbatum Baill. Taepo, Martaban hills, *Gallatly.*

Nyssa bifida Craib. Dawna hills at Misty hollow, *Parkinson.*

Nyssa megacarpa Parker. Dawna hills, *Lace.* Nwalabo at 3,500 ft., *Parker.*

RUBIACEAE.

Adina polycephala Blume. Dawna hills at 4,000 ft., *Lobb*; near Misty Hollow, *Parkinson.*

Hymenopogon parasiticus Wall. Slopes of Mulayit on trees and rocks, *Parkinson.*

Mussaenda polyneura King. Nwalabo at 3,500 ft., *Parker.*

Mycetia parishii Craib. Spur to Mulayit at 3,000 ft., *Parish, Beddome.*

Ophiorrhiza umbricola W. W. Smith. Mulayit at 6,200 ft., *Parkinson.*

Psychotria monticola Kurz. Myinmolekat at 5,000 ft., *Parker.*

Saprosma consimile Kurz. Mulayit, *Gallatly, Lace.*

Spathichlamys oblonga Parker. Myinmolekat at 4,000 ft., *Parker.*

COMPOSITAE.

Ainsleia pteropoda D.C. Summit of Mulayit, *Parish, Parkinson.*

Anaphalis araneosa D.C. Mulayit, *Parkinson.* Martaban hills at 5,000 ft., *Maung Po Chin.*

Gynura angulosa D.C. Mulayit ridge at 5,500 ft., *Parkinson.*

Lactuca (*hastata* D.C.) Mulayit ridge at 4,000 ft., *Parkinson.*

Senecio densiflorus Wall. Dawna hills at 5,000 ft., *Lobb.* Mulayit at 4,000 ft., *Parkinson.*

Senecio kurzii Clarke. Summit of Mulayit, *Parish, Parkinson.* Dawna hills, *Lobb.*

Vernonia taroyana Fischer. Nwalabo at 3,500 ft., in grass, small bamboo and shrub complex, *Parker*. Maungpok-Nwalabo ridge at 3,300 ft., *C. G. Rogers*.

VACCINIACEAE.

Agapetes bracteata Hook. f. Dawna hills at 5,000 ft., *Lobb, Parish*.

Agapetes campanulata Clarke. Nattoung at 7,000 ft., *Kurz*. Dawna hills, *Parish*.

Agapetes lobbii Clarke. Dawna hills at 5,000 ft., *Lobb*.

Agapetes loranthifolia. D. Don. Dawna hills, *Lobb, Lace*.

Agapetes parishii Clarke. Nattoung, *Parish*, Dawna hills at 5,000 ft., *Lobb*. Mulayit, *Parkinson*. Myinmolekat at 5,000 ft., *Parker*.

Agapetes saligna Hook. f. Dawna hills at 5,000 ft., *Lobb*.

Agapetes setigera D. Don. Mulayit, *Parkinson*.

Vaccinium bancanum Miq. Dawna hills, *Lace, Parkinson*.

Vaccinium donianum Wight. Myinmolekat at 5,000 ft. *Parker*.

ERICACEAE.

Craibiodendron stellatum W. W. Smith. Dawna hills, *Lace*.

Rhododendron arboreum Smith. Mulayit, *Parkinson*.

Rhododendron formosum Wall. Mulayit, *Lace, Parkinson*. Nattoung, *Kurz*.

Rhododendron moulmainense Hook. Dawna hills at 5,000 ft., *Lobb*. Myinmolekat at 6,000 ft., *Parker*.

Rhododendron parishii Clarke. Mulayit, *Parish, Lace*. Myinmolekat at 6,000 ft., *Parker*.

Rhododendron veitchianum Hook. Mulayit, *Beddome, Parish*, etc., Myinmolekat at 6,000 ft., *Parker*.

MYRSINACEAE.

Ardisia dawnaea C. E. Parkinson nom. nov., *A. gracilis* Lace in Kew Bull. (1914) p. 158 non Miq. (1856): Mulayit, *Beddome, Lace, Parkinson*. Lace in naming the Mulayit plant overlooked the fact that the trivial name *gracilis* had already been given by Miquel to a Brazilian plant in the genus.

Ardisia brandisiana Kurz. Dawna hills at 5,500 ft., *Brandis, Lobb, Lace*.

Embelia parviflora Wall. Nwalabo at 3,000 ft., *Parker*.

Embelia ribes Burm., same locality as the preceding.

Maesa permollis Kurz. Spur to Mulayit at 3,500 ft., *Lace*. Dawna hills, *Parkinson*.

Myrsine capitellata Wall. Slopes of Mulayit at 4,000 ft., *Parkinson*.

STYRACACEAE.

Symplocos ferruginea Roxb. Dawna hills, *Lace*.

Symplocos sulcata Kurz. Nattoung, *Kurz*. Dawna hills, *Lobb*.

OLEACEAE.

Fraxinus floribunda Wall. Ta-ok plateau at 3,000 ft., *Lace.*

Jasminum latipetalum Clarke. Dawna hills at 5,000 ft., *Lobb.* Slopes of Mulayit, *Parkinson.*

Jasminum nobile Clarke. Dawna hills at 4-5,000 ft., *Lobb, Parish, Lace.*

Olea dentata Wall. Dawna hills at 3,000 ft., *Parish, Lace.*

APOCYNACEAE.

Rauwolfia peguana Kurz. Dawna pass from the Thaungyin at 5,000 ft., *Brandis,* April 1859.

SCROPHULARIACEAE.

Brandisia discolor Hk. f. & Th. Martaban hills, Taepo at 5,000 ft., *Brandis.* Dawna hills, *Parish.*

Wightia lacei Craib. Mulayit, *Parkinson.* Ta-ok plateau, *Lace.*

ACANTHACEAE.

Ebermaiera beddomei Clarke. Mulayit, *Beddome.*

Justicia caloneura Kurz. Mulayit, *Beddome.*

Justicia grandifolia T. And. Mulayit, *Beddome.* Dawna hills, *Parish, Lace.*

Justicia vasculosa Wall. var. *parishii* Clarke. Mulayit, *Beddome.* Dawna hills, *Parish, Lace, Parkinson.*

Strobilanthes lamioides T. And. Taepo at 4,000 ft., *Brandis.*

Strobilanthes parishii Clarke. Slopes of Mulayit, *Beddome.* Dawna hills, *Parish.*

Strobilanthes spathulatus Parker. Myinmolekat at 4,000 ft., *Parker.*

LABIATAE.

Colquhounia elegans Wall. var. *tenuiflora* Prain. Dawna hills, *Parish, Lace.*

POLYGONACEAE.

Polygonum molle Don. Summit of Mulayit, *Parkinson.*

Polygonum rude Meissn. Nattoung hills at 7,000 ft., *Kurz.*

RAFFLESIACEAE.

Sapria himalayana Griff. Slopes of Mulayit at 4 000 ft., *Parkinson.*

LAURACEAE.

Lindera caudata Benth. Taepo at 4,000 ft., *Brandis.* Martaban and Tenasserim hills at 6,000 ft., *Kurz.*

Lindera pulcherrima Benth. Same localities as the preceding.

Machilus kingii Hook. f. Dawna hills, *Lace.*

Machilus kurzii King. Dawna hills, *Lace.*

Machilus sp.; Mulayit at 6,100 ft., *Parkinson* No. 5152.

Machilus sp.; Mulayit at 6,300 ft., *Parkinson* No. 5155.

Neolitsea zeylanica Merr. Nwalabo on exposed ridges at 4,000 ft., and Myinmolekat at 4-5,000 ft., *Parker.* This may prove to be distinct from the true *N. zeylanica.*

THYMELEACEAE.

Daphne involucrata Wall. Dawna hills at 5,000 ft., *Beddome, Parish, Parkinson.*

Daphne pendula Sm. Nattoung hills, *Parish.* Myinmolekat at 4,500 ft., *Parker.*

LORANTHACEAE.

Loranthus brandisii Kurz. Nattoung, *Parish.* Taepo at 3,000 ft., *Brandis.* Dawna hills, *Lace.*

Loranthus hypoglaucus Kurz. Dry forests of Nattoung ridge at 6,000 ft., *Kurz.*

Loranthus parishii Hook. f. Dawna hills, *Parish.*

BALANOPHORACEAE.

Balanophora indica Wall. Dawna hills at 3-5,000 ft., *Lace.*

EUPHORBIACEAE.

Daphniphyllum beddomei Craib. Mulayit at 6,000 ft., *Beddome, Lace.*

Glochidion desmogyne Hook. f. Mulayit at 6,000 ft., *Gallatly.*

Macaranga brandisii King. Mulayit at 5-6,000 ft., *Beddome, Gallatly.*

Trigonostemon lanceolatus Pax. Mulayit, *Beddome.*

MYRICACEAE.

Myrica nagi Thunb. Mulayit. *Beddome, Parish,* etc.

BETULACEAE.

Carpinus londoniana Winkl. Dawna hills, *Lace, Parkinson.* Martaban hills at 5-6,000 ft., *Kurz.*

FAGACEAE.

Castanopsis parishii King. Dawna hills, *Parish.*

Quercus brandisiana Kurz. Ta-ok plateau, *Lace.*

Quercus calathiformis Skan. Slopes of Mulayit, *Parkinson.*

Quercus eumorpha Kurz. Mulayit, *Lace, Parkinson.* Myinmolekat at 6,500 ft., *Parker.*

Quercus helferiana A. DC. Tenasserim hills at 4,000 ft., *Gallatly.*

Quercus semiserrata Roxb. Slopes of Mulayit, *Parkinson.* Dawna hills, *Lace.*

Quercus kingiana Gamble. Myinmolekat, *Parker.*

CONIFERAE.

Pinus merkusii Jung. & De Vries. Eastern slopes of the Dawnas on the Thaungyin side, *Parkinson.*

DIOSCOREACEAE.

Dioscorea dawnaca Prain and Burkill. Dawna hills at 3,000 ft., *Burkill.*

ORCHIDACEAE.

Bulbophyllum gracile Par. & Reichb. f. Mulayit at 3,500 ft., *Parish.*
Bulbophyllum lobbii Lindl. Dawna hills, *Lobb, Parish.*
Bulbophyllum lemniscatum Parish. Dawna hills, Ta-ok plateau and Mulayit, *Parkinson.*
Bulbophyllum macranthum Lindl. Tenasserim hills at 3,600 ft., *Parish.*
Bulbophyllum parviflorum Par. & Reichb. f. Dawna hills, *Parish.*
Bulbophyllum suavissimum Rolfe. Slopes of Mulayit, *Parkinson.*
Cirrhopetalum retusiusculum Reichb. f. Mulayit near the summit, *Parish, Parkinson.*
Coelogyna cyenoches Par. & Reichb. f. Dawna hills at 4,000 ft., *Parish.*
Cymbidium tigrinum Parish. Mulayit at 6,000 ft., *Parish.*
Dendrobium infundibulum Lindl. Dawna hills at 4-5,000 ft., *Lobb, Parish.*
Dendrobium xanthophlebium Lindl. Dawna hills at 4,500 ft., *Parish, Lobb.*
Drymoda picta Lindl. Dawna hills at 5,000 ft., *Parish.*
Eria concolor Par. & Reichb. f. Mulayit, *Gallatly.*
Eria conica Summerhayes. Dawna hills near Misty hollow, *Parkinson.*
Eria lacei Summerhayes. Dawna hills at 3,500 ft., *Lace.*
Eria pleurothallis Par. & Reichb. f. Mulayit at 5,000 ft., *Parish.*
Eria pulchella Lindl. Tenasserim hills at 4,000 ft., *Parish.*
Eria truncata Lindl. Dawna hills at 4-5,000 ft., *Lobb.*
Eulophia bracteosa Lindl. Dawna hills at 3,500 ft., *Parish.*
Henosis longipes Hook. f. Dawna hills at 4-5,000 ft., *Lobb.*
Otochilus porrecta Lindl. Mulayit at 5,000 ft. and Martaban hills, Nattaoung summit, *Parish.*
Spathoglottis lobbii Reich. f. Dawna hills, *Lobb.*
Sunipia scariosa Lindl. Tenasserim hills at 4-5,000 ft., *Parish.*
Vanda denisoniana Benson and Reichb. f. Ta-ok plateau, *Parish.*

CYPERACEAE.

Carex arridens Clarke. Nattoung at 4,000 ft., *Parish.*
Gahnia javanica Moritzi. Myinmolekat at 6,800 ft., *Parker.*

GRAMINACEAE.

Arundinaria gallatlyi Gamble. Mulayit peak at 5,500 ft., *Gallatly, Parkinson.* Nwalabo ridge, *C. G. Rogers.*
Arundinella setosa Trin. Mulayit peak at 6,400 ft., *Parkinson.*
Dinochloa marginata Munro. Dawna hills between the Thaungyin and the Haungtharaw at 5,000 ft., *Brandis.*
Ischaemum cilliare Retz. Mulayit at 6,000 ft., *Lace.*
Klemachloa detinens Parker. Myinmolekat at 4,000 ft., *Parker.*
Melocalamus compactiflorus Benth. & Hk. f. Ta-ok plateau, *Parkinson.*

SWISS DATA FOR FORESTS AND RAINFALL.

Researches in comparative meteorology were conducted under the direction of Professor Buhler in one of the Swiss Forest Research Stations near Haidenhaus, not far from Lake Constance, Canton Thurgovie, at a height of about 700 m. from 1890 to 1897. Figures were collected in an open field in a beech wood 50 years old, and in a spruce pole forest 40 years old. The detailed observations made have been partially published but the statistics then collected have never been interpreted as a whole.

To-day study in comparative meteorology awakens much interest among those who are concerned with silviculture and the study of soil ecology. For this reason we publish a précis of the results as now interpreted by Professor Hans Bürger in the current number of the Swiss Forest Research *Mitteilungen* of 1933, XVII-I.

I.—PRECIPITATION.

(*i*). From 1891 to 1895 the minimum precipitation which fell directly into the rain gauge was 896 mm. in open field, 666 mm. in broadleaf forest (a 50-year old beech wood), 461 mm. in coniferous forest (a 40-year old spruce wood). The measured fall in the beech wood is 74 per cent. of that in the open field and that of the spruce copse 52 per cent.

(*ii*). In the beech wood 82 per cent. of the precipitation finds its way through the canopy and penetrates to the soil in winter; in summer 69 per cent. In the spruce copse 51 per cent. pierces the crowns in winter, 52 per cent. in summer. Thus in the beech the amount of precipitation which penetrates the soil is much greater in winter than in summer; in the spruce this is not the case.

(*iii*). From December to March the curve of precipitation in the beech wood follows fairly faithfully that of the station in the open; from May to September it rather resembles that in the spruce.

(*iv*). The capacity of the beech crowns to retain precipitation is fairly constant during the months they are without leaves, it increases

as soon as the leaves start coming out, attains its maximum in summer, and in autumn diminishes progressively until leaf-fall is complete. In the spruce this capacity does not vary much following the seasons but is however slightly greater during winter snowfall than during the summer rain.

(*v*). The crowns retain a greater proportion in the smaller showers. The spruce retains a much higher percentage than the beech of slight showers of snow or rain, even in summer.

2. DURATION OF SUNSHINE.

(*i*). The total duration of insolation was 1,736 hours, averaging 4·8 hours a day, being 1,240 hours (6·8 hours a day) or 71 per cent. for the six summer months and 496 hours (2·7 hours a day) or 29 per cent. for the winter. The maximum monthly insolation which was registered in April 1893 was 303 hours or 10·1 hours a day; the minimum in December 1895 with only 17 hours or 0·5 hours per day.

(*ii*). The intensity of insolation augments slowly from dawn till mid-day, attains its maximum between noon and 3 p.m., and diminishes rapidly towards 6 p.m. The intensity of insolation augments very slowly during the morning, particularly in autumn and winter, which leads to the supposition that the formation of fogs on Lake Constance is related to this fact.

(*iii*). The effect of insolation on the temperature of the air in winter was not established by these observations which only lasted five years. However the effect is as follows for the other seasons; in spring in the open each addition or diminution of an hour's sunshine makes a minimum change in the air temperature of 0·54°, in summer 0·45° in autumn only 0·24°.

(*iv*). With 8 hours' sunshine per day a minimum temperature of 3° in winter, 9° in spring and autumn, and 16·5° in summer can be attained. The following example shows how the winter cold persists in the spring and the summer warmth in the autumn: March with a daily insolation of 4·7 hours has a monthly mean temperature of 2·3°. October on the contrary with the feeble average insolation of 3·7 hours still has a temperature of 8·3°.

3. TEMPERATURE OF THE SOIL.

(*i*). The temperature of the soil at depths of from 5 to 120 cm. is almost the same over a year : in a leafy forest it is about 2° lower than in the open.

(*ii*). In winter in the forest as well as in the open the temperature of the first 5 cm. is 4° lower than at a depth of 120 cm. In summer on the contrary the temperature of the top 5 cm. of soil is 5° higher than at 120 cm. in the open and 4° higher in the beech wood. At the same time the temperature of the forest soil is about 4° less than in exposed soil. In spring and autumn conditions are intermediate between these extremes.

(*iii*). At a depth of only 30 cm. even large variations in the air temperature have no immediate effect—their action is retarded and greatly diminished. In winter the lowest yearly temperature of the surface soil coincides exactly with the lowest position of the sun in December. During January and February while the surface temperature increases, at 120 cm. depth it continues to decrease until the end of February and even until the beginning of March.

(*iv*). While at a depth of 5 cm. the soil temperature attains its maximum in July, at 120 cm. the maximum is only reached one month to 1½ months later—that is in August or September.

(*v*). The effect of a forest canopy on the variations of soil temperature in comparison with conditions in the open is comparable to the isolating effect of mulching the top soil in a garden. Naturally a forest in leaf acts more efficaciously than when leafless.

(*vi*). Average monthly temperatures are as follows :—

Depth of—

Station.	*5 cm.*	*30 cm.*	*60 cm.*	*90 cm.*	*120 cm.*
In the open ..	21·1°	18·2°	16·0°	13·5°	11·5° C
In beech wood ..	15·8°	13·8°	11·6°	9·8°	8·1° C

In the open the monthly averages are thus twice as cold at 120 cm. compared with the soil surface. In the beech wood the variation is about ⅓ less than that of exposed soil.

(*vii*). The following variations during May 1894 were established showing how rapid is the increase in the summer temperature :—

Station.		*At 5 cm. depth.*	*At 120 cm. depth.*
Open	..	12°	4°
Beech wood	..	6·5°	1·5°

The canopy and humus in the beech thus reduced by half the variations of the soil temperature.

3. EVAPORATION.

(*i*). The average evaporation from 1891 to 1895 was as follows :—

Station.		*Whole year.*		*Summer months only.*		*Winter months only.*	
Open	..	928 mm.	100%	717 mm.	100%	211 mm.	100%
Beech wood	..	372 mm.	40%	276 mm.	38%	96 mm.	45%
Spruce	..	254 mm.	27%	201 mm.	28%	53 mm.	25%

(*ii*). Thus it can be generally stated that the atmosphere under forest foliage is much more like that on the ocean than that of open ground.

(*iii*). The beech wood relatively speaking reduces evaporation more in summer than in winter, but this is not the case with the spruce.

(*iv*). $\frac{3}{4}$ of the evaporation takes place in summer and $\frac{1}{4}$ in winter. However if one takes into account the effect of frost on the humidity gauge during the cold season $\frac{2}{3}$ to $\frac{3}{4}$ of the evaporation can be credited to summer, $\frac{1}{4}$ to $\frac{1}{3}$ to winter.

(*v*). The assessed evaporation in the forest in contrast to that of exposed ground is higher in spring than in autumn, the humidity in the air being less and the aerial currents more marked than in the height of summer and in autumn. In April 1893 evaporation was stronger with an average temperature of 11° than in August of the same year with a temperature of 17·6°.

(*vi*). From 1891 to 1895 evaporation in the open was 3·9 grammes per hour during the day, but only 0·89 (or 21 per cent.) during the night. In the forest evaporation during the day was never greater

than 1·39 grammes per hour or 0·7 grammes (or 54 per cent.) during the night. Thus evaporation during the day in the open is three times greater than in the forest while during the night it is almost the same for both.

(*vii*). During the summer six months the nocturnal evaporation in the open represents only 20 per cent. of the day-time evaporation; in the forest on the contrary it represents 50 per cent. In winter the retarding effect of darkness diminishes. Thus the nocturnal evaporation in the open is 29 per cent. of the day-time evaporation while in the beech wood it increases to 57 per cent. If there is only slight evaporation during the night it is because either the temperature or the wind has increased during the day and therefore the humidity of the air has diminished.

(*viii*). The differences caused by the strength of the wind, the temperature, and the humidity during the day and night are much more marked in summer than in winter. The effect which the night has in reducing evaporation is therefore diminished in winter.

(*Translation by S. G. G.*).

[The practical importance of researches of this nature may be realised when we remember the effect of excessive exposure and evaporation in most of our forest regeneration problems in India, whether natural or artificial. There are also the wider questions of the effect of dew and rain in the leaching of soil nourishment from exposed surfaces, and the local influence of the forest on the water supply in springs and streams. It must be remembered, however that the foregoing figures are for temperate European conditions with no monsoon rainfall and with much lower hot weather temperatures than we experience in India, so that they may not be directly applicable to Indian conditions. By quoting Herr Bürger's results in full we wish rather to emphasise the importance which European foresters attach to such studies in the hope that it will stimulate forest officers in India to take up similar studies in their own districts.—ED.]

PYRETHRUM.

By S. V. Puntambekar, M.Sc., Ph.D., Chemical Branch, Forest Research Institute.

With the possible exception of *Derris* there is no other vegetable insecticide available that is as effective as pyrethrum for destroying the insect enemies of plants, animals and human beings. During the last dozen years, this insecticide has attracted a world-wide attention as one superior even to the well-tried preparations of arsenic and lead on account of its being harmless to higher animals and to human beings. Its popularity may be gauged from the fact that its production in Japan, which at present supplies 70 per cent. of the world's requirements, rose from 279,931 lbs. in 1911 to 11,622,906 lbs. (priced at £569,038) in 1928. The Oil, Paint and Drug Reporter for January 1 (1934), p. 38 says:—"Pyrethrum production in Japan in the 1933 season amounted to 6,355 long tons (14,235,200 lbs.). .... As the Japanese people become increasingly educated to the use of insecticides and smudge sticks, domestic demand constantly becomes heavier. It is estimated that nearly 50 per cent. of the current crop will be consumed in Japan." Vigorous attempts are, therefore, being made by America, England and some of the European countries to grow and cultivate this valuable plant (*Pyrethrum cinerariaefolium* Trev., syn. *Chrysanthemum cinerariaefolium* Boic) in order to meet their increasing requirements, and a recent article on the subject by Dr. McTaggert (1) shows that Australia is also in the same pursuit.

Although the amount of this insecticide at present imported into India is too small to deserve any notice yet its increasing demand in years to come cannot be ignored, for India is primarily an agricultural country and it is in agriculture that the importance of pyrethrum has been fully realised. And as such, the importance of cultivating this plant in India becomes obvious. A survey of the available literature on the subject together with experimental work (to be published later) by the writer makes him feel quite hopeful about the successful cultivation of pyrethrum in some parts of Northern India.

The insecticidal properties of *Chrysanthemum roseum* Web and Mohr, (syn. *Pyrethrum carneum*, M.B., the red flowered species) appear to have been known in Persia for several centuries, and from there it found its way into Europe in the early part of the last century. Soon afterwards a valuable species, *Chrysanthemum cinerariaefolium*, Boic (the yellow and white flowered species) was bred in Dalmatia whence it was introduced into Japan in 1881. America took to its cultivation in the beginning of this century while England and Australia got interested in the problem in the last ten years or so.

Of the numerous species of pyrethrum growing all the world over, either wild or cultivated, only a few have been found to possess the desired toxicity. The Insecticide and Fungicide Board of the United States of America, Department of Agriculture (3) recognizes only the following species of pyrethrum as a source of the insecticide, namely, (*a*) *Chrysanthemum cinerariaefolium* Boic, (*b*) *C. roseum* Web and Mohr, and (*c*) *C. marshallii* Ashers. It is only the *C. cinerariaefolium*, however, that predominates in trade. The species (*b*) and (*c*) are also grown, but only to a limited extent, in Persia and North Caucasus and no attempt is made for their cultivation on a large scale. In India the following species are found: (*a*) *Chrysanthemum coronarium* Lin., (*b*) *C. indicum* Lin., (*c*) *C. leucanthemum* Lin., naturalized in Simla, Dalhousie and Chakrata, and (*d*) *C. atkinsonii* occurring in Sikkim. The first two are commonly grown in the gardens of India and are also used in indigenous medicine for various types of bodily ailments, especially in the treatment of gonorrhea. Except *C. leucanthemum* Lin. (the daisy) which is reported to be inactive, none of the other species have been studied for their toxicity. In view of the reported medicinal properties of the garden species, the chemical nature of the active principles of which is more or less known (4) determination of their toxicity would form an interesting study.

The insecticidal activity of the pyrethrum plant is due to two closely related chemical compounds Pyrethrin I and Pyrethrin II, both being esters of a common ketonic alcohol, pyrethrolone, and a monobasic and a dibasic acid respectively. Neither the alcohol nor

the acids are individually toxic to insects. It is only their combination (Pyrethrins I and II) that is so, Pyrethrin I being 1·25 times as strong in its toxic properties as Pyrethrin II (5). The researches of Gnadinger and Corl in America and Tattersfield *et al* in England indicate that there is a close relation between the pyrethrin content and the toxicity of the pyrethrum.

Pyrethrins are concentrated in the flower head, and though the stalk, leaves and root contain a little of them the amount is negligible. The pyrethrin content also varies in the different species. In many it is very small or totally absent and among the few species that are known to contain the pyrethrins *Chrysanthemum cinerariaefolium* Boic occupies the top place yielding as much as 1·75%. Pyrethrins are effectively extracted from powdered pyrethrum flowers by petroleum ether and kerosene. Chlorinated solvents like ethylene chloride, carbon tetrachloride, etc. are also often used in commerce but when water soluble preparations are desired pyridine and ethyl acetate are employed. Extracts made with these solvents, if properly stored, would keep their activity unimpaired for about a year. Though methyl and ethyl alcohol can efficiently extract the pyrethrins yet they are not recommended for the purpose since they bring about an interchange of esters which is followed by the loss of their toxicity.

In order to estimate the pyrethrin content of powdered pyrethrum or its preparations two chemical methods of assay are generally used, namely (A) *the copper reduction method* in which an alkaline copper solution is reduced by the pyrethrin molecule and the amount thus reduced is measured by comparison with a saturated dextrose solution (6), (B) *the rapid acid method* in which the pyrethrum extract freed from fat and other interfering compounds is saponified by alcoholic sodium hydroxide, the alcohol distilled off and the residue made acid with dilute sulphuric acid. The resulting mixture is steam distilled and the distillate containing the pyrethric acid (monobasic) is volumetrically estimated, (7). Both of these methods however have limited application. For instance the method A is worthless if the powder or its extract is adulterated with some substance that would reduce

alkaline copper solution and the method B will give abnormal results if the pyrethrum preparations are mixed with esters of volatile acids. In view of these drawbacks it is often better especially for the analysis of industrial preparations, to employ a suitable biological method of assay (8) which readily brings out their insecticidal values without having to know their pyrethrin content.

Some of the common insects and insect pests effectively destroyed by pyrethrum are lice, bugs, beetles, fleas, mosquitoes, flies, caterpillars, aphids, ants and cockroaches. Pyrethrum is known to be toxic to cold-blooded animals, paralyzing their nerves and muscles, but not to the warm-blooded ones like sheep dogs, etc., the reason being that when used on the former class the physiological activity of the pyrethrins is not lost whereas in the latter case their contact with warm blood causes the breakdown (enzymetic hydrolysis ?) of the pyrethrin molecule with the subsequent loss of its activity. In this respect it is observed that poisoned insects survive when kept at 36°C but the controls die at 16°C.

The toxicity of pyrethrum powders and pyrethrum extraction on a number of insects have been determined and in general it is noted that the extracts are more effective than the powders. This is so because in the powders the pyrethrins are to a large extent still held firmly in the plant cells whereas in the case of extracts they are in a free state. In the case of the soap emulsions of the extracts it is necessary that they are used immediately after they are prepared, otherwise the free alkali of the soap or that from its hydrolysis will soon destroy much of its toxicity. This is obviously due to the saponification of the pyrethrins. Different kinds of insects need a different minimum lethal dose and therefore before its use pyrethrum preparation should be standardised on the insects it is meant to destroy.

The medicinal value of pyrethrum especially of the two Indian species has already been mentioned above. *Chrysanthemum cinerariaefolium* has been recently studied pharmacologically and also found to possess some valuable medicinal properties. It is found to be highly toxic to intestinal parasites. *Ascaris lumbricoides* of the pig and

taenias of the dog are promptly killed by a dilute solution of the drug. Excellent results have also followed on its use in human beings infested by various worms (9). A jelly preparation of pyrethrum has been found effective in the treatment of scabies (10) and in about 0·1% concentration it is observed to check bacterial growth.

Pyrethrum thrives well in a poor sandy soil. The use of fertilizers, in general, has very little effect other than, in a few cases, of increasing the yield of flowers per acre. With superphosphate however it has been found that the active principle increases. As the pyrethrin content reaches the maximum in a fully opened flower and begins to diminish thereafter, the flowers should not be harvested before they are fully opened nor after they are full-blown. The experiments of Tattersfield and co-workers show that in a temperate climate the number and the pyrethrin content of the flowers are reduced by diminishing the illumination *i.e.*, by cutting off the hours of daylight. In tropical countries like Uganda, Tanganyika, Trinidad, etc., the plant grows but will not produce flowers, whereas on the uplands of Kenya a good crop of flowers of high toxicity is produced.

For fuller and detailed information on the subject the recently published book, *Pyrethrum Flowers* by Prof. C. L. Gnadinger (Mc Laughlin Gormley King Co., 1715 S. E. Fifth Street, Minneapolis, Minn. U.S.A. $ 3·50) may be consulted.

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SIMPLER CONTROL FORMS.

BY H. L. WRIGHT, B.A., F.R.G.S. I.F.S.

Great improvements have been effected in the maintenance of control forms during the last 20 years. Previously, in too many divisions, these were little more than another set of accounts, the main object of which, so it seemed, was to give the clerks in the circle and divisional offices an opportunity of raising and answering a formidable series of objections.

But with the introduction of working plans with a volume control, it was realised that actual control was an essential part of a conservator's duty and that control forms must be prepared so as to enable him to see exactly how work under the plan was progressing. This was clearly laid down in the chapter dealing with control in Trevor and Smythies' *Practical Forest Management*. "Working plans are of no use," it is stated, "unless they are adhered to and proper adherence can only be secured by effective control. This control should be devoted to an examination of the works actually prescribed and carried out and to the control of the actual compared with the prescribed yield. At all costs should the elaboration of control forms into account forms be avoided and the system of control should be simple and effective."

Previously Code Form No. 2 was universally used for the control of all kinds of fellings, but as this form was not always suitable, the tendency became for each working plan officer to prescribe a modified form to fit the prescriptions of his plan. Typical modified forms are printed at pages 186—189 of *Practical Forest Management*, and forms very similar to these are now standardised in the Punjab for the control of main and subsidiary fellings under working plans prescribing management under the uniform or shelterwood system.

These forms well serve the objects for which they were designed, which, in Punjab Forest Leaflet No. 11, are clearly enunciated as

under :—

(*i*) To compare the actual fellings or other exploitation of the year with the working plan or working scheme prescriptions, and to enable the controlling authority to see how far the provisions of a sanctioned plan as regards fellings have been carried out and where they have been departed from.

(*ii*) To enable the divisional forest officer to ascertain at the beginning of each year what arrear or advance fellings or other matters have to be adjusted in the current year.

But they have one drawback, their size, and, if the control book is to be taken into camp, its weight. The Punjab standard form measures 27″×17″ and a bound control book weighs five pounds so that if a conservator wishes to take the control books for several working plans on tour with him, they mean a considerable addition to his office records.

Moreover they are very unwieldy to handle on a small camp office table and after struggling for some days with the control book for a comparatively simple working plan which had been in force for ten years, I amused myself during the long winter evenings in camp trying to get all the information necessary for an effective control of the plan into somewhat less bulky form. The result is given in the two forms printed at the end of this article.

Form A relates to the main fellings ; in this case regeneration fellings under the uniform system, with a volume control. The whole of the work done during the ten years the working plan had been in force is given in the form, which in manuscript can easily be written on a double sheet of foolscap.

It omits all information not essential for control purposes, such as details of the trees marked and agency of exploitation, information which can more suitably be given in the Compartment Histories. On the other hand, it gives very valuable information, which at present finds no place in Control Form No. 2-A. For instance, the volume of growing stock per acre gives the controlling officer at least some idea

of the stocking of the compartment before fellings were started, while a comparison of the volume cut with the enumerated growing stock at once gives an indication of the intensity of the fellings.

With ten years felling figures all on the page, the conservator can also see straight away, without having to turn backwards and forwards through an unwieldy control book, the date any compartment came under working; whether work was completed in one year or delayed; in fact, the whole felling history of each and every compartment. As regards the purely arithmetical side of control, nothing could be simpler or more effective than the bottom lines of the form which show at a glance the position at the close of any year of the working plan period.

Having dealt with the control of the main fellings, I next turned to the subsidiary fellings, in this case thinnings on a ten years' cycle over the remainder of the working circle not allotted to P. B. I.

Form B was the result, an extract from which is attached, which shows how it was prepared. This is not quite so satisfactory as Form A, yet even so it gives all the information a controlling officer is likely to need, and it again has the advantage of compressing the whole of the data of ten years' working on to three double pages of foolscap.

As in Form A, the bottom lines of the form provide the purely arithmetical control and in this case control being by area, the deviation at the end of each year is merely the number of acres the thinnings are in arrears or in advance. This is the chief thing the conservator wants to know, as he can thus see whether work is keeping pace with the prescription or not. If, however, details of the deviations are wanted he can readily see by glancing through the form whether any particular compartment was felled during the year prescribed or earlier or later.

The working plan for which these forms were prepared deals with only one species so in the case of the main fellings controlled by volume no further control is necessary. But where the prescribed volume includes several species, especially where one is much more

FORM A.

CONTROL BOOK OF THE REGULAR WORKING CIRCLE.

LOWER SIRAN RANGE.

Main Fellings.

Compartment Name and Number.	Area.	Enumerated growing stock.	Volume per acre.	VOLUME FELLED. 1923-24. Volume felled.	1924-25. Volume felled.	1924-25. Total to date	1925-26. Volume felled.	1925-26. Total to date.	1926-27. Volume felled.	1926-27. Total to date.	1927-28. Volume felled.	1927-28. Total to date.	1928-29. Volume felled.	1928-29. Total to date.	1929-30. Volume felled.	1929-30. Total to date.	1930-31. Volume felled	1930-31. Total to date.	1931-32. Volume felled.	1931-32. Total to date.	1932-33. Volume felled.	1932-33. Total to date.
	Acres.	c. ft.	c. ft.																			
Tanglai 5 (*i*) ..	255	474,424	1,860	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
,, 5 (*ii*) ..	213	381,559	1,804	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	250,182	250,182
,, 6 ..	243	417,263	1,717	..	..	..	..	..	..	..	..	..	..	..	..	..	122,036	122,036	155,419	277,455	42,037	319,492
,, 9 (*i*) ..	159	351,489	2,211	..	..	..	..	..	..	..	..	..	..	..	..	..	164,893	164,893	38,661	203,554	..	203,554
,, 9 (*ii*) ..	147	235,667	1,603	..	..	..	..	..	..	..	..	..	..	..	..	..	109,957	109,957	39,053	149,010	..	149,010
Baz Khan 1 (*i*) ..	293	655,742	2,238	..	2,982	2,982	398,209	401,191	118,466	519,657	14,555	534,212	..	534,212	..	534,212	..	534,212	..	534,212	..	534,212
,, 3 ..	244	420,625	1,724	..	..	..	..	..	..	..	241,731	241,731	..	241,731	30,800	272,531	26,592	299,123	..	299,123	..	299,123
Daddar 2 (*i*) ..	124	230,121	1,856	..	..	..	..	..	182,529	182,529	..	182,529	1,652	184,181	12,898	197,079	..	197,079	..	197,079	..	197,079
,, 2 (*ii*) ..	187	342,970	1,834	..	..	..	..	..	81,627	81,627	160,153	241,780	..	241,780	..	241,780	..	241,780	..	241,780	..	241,780
,, 2 (*iii*) ..	219	539,913	2,465	..	..	..	..	..	..	..	102,849	102,849	..	102,849	208,285	311,134	..	311,134	33,261	344,395	..	344,395
Massar 5 (*i*) ..	197	533,004	2,706	..	..	..	..	..	..	..	..	..	..	..	215,197	215,197	83,902	299,099	..	299,099	..	299,099
,, 5 (*ii*) ..	126	340,502	2,544	..	..	..	..	..	..	..	..	..	111,242	111,242	..	111,242	78,696	189,938	..	189,938	..	189,938
,, 5 (*iii*) ..	151	430,043	2,848	..	..	..	..	..	..	..	..	..	271,137	271,137	7,461	278,598	..	278,598	..	278,598	..	278,598
,, 10 (*ii*) ..	181	409,591	2,263	..	153,887	153,887	70,295	224,182	5,874	230,056	..	230,056	..	230,056	..	230,056	..	230,056	..	230,056	..	230,056
Batrassi 1 (*i*) ..	142	236,462	1,665	..	139,067	139,067	..	139,067	4,445	143,512	750	144,262	446	144,708	..	144,708	1,670	146,378	..	146,378	1,223	146,601
,, 1 (*ii*) ..	165	251,038	1,523	..	128,781	128,781	..	128,781	5,107	133,888	608	134,496	223	134,719	..	134,719	543	135,262	..	135,262	1,686	136,948
,, 2 (*i*) ..	99	152,502	1,530	..	68,450	68,450	..	68,450	..	68,450	604	69,054	821	69,875	..	69,785	707	70,582	..	70,582	152	70,734
, 4 (*i*) ..	198	260,123	1,314	136,541	446	136,987	1,580	138,567	2,218	140,785	..	140,785	606	141,391	..	141,391	868	142,259	..	142,259	990	143,249
,, 4 (*ii*) ..	180	263,472	1,464	150,251	304	150,555	1,651	152,206	15,497	167,703	862	168,565	902	169,467	..	169,467	1,162	170,629	..	170,629	606	171,235
,, 4 (*ii*) ..	88	161,220	1,832	91,654	240	91,894	678	92,572	2,861	95,433	544	95,977	758	96,735	..	96,735	240	96,975	..	96,975	375	97,350
Total ..	3,611	7,087,730	1,963	378,446	494,157	872,603	472,413	1,345,016	418,624	1,763,640	522,656	2,286,296	387,787	2,674,083	474,641	3,148,724	591,266	3,739,990	266,394	4,006,384	297,251	4,303,635
Prescribed Yield	..		..	450,000	450,000		450,000		450,000		450,000		450,000		450,000		450,000		450,000		*283,560	
Balance forward	..		..	..	71,554		27,397		4,984		36,360		—36,296		25,917		1,276		—139,990		43,616	
Total to be felled	..		..	450,000	521,554		477,397		454,984		486,360		413,704		475,917		451,276		310,010		317,116	
Deviation	..		..	—71,554	—27,397		—4,984		—36,360		**+36,296**		—25,917		—1,276		**+139,990**		—43,616		—29,865	

*Yield reduced under C. C. F.'s orders.

FORM B.

CONTROL BOOK OF THE REGULAR WORKING CIRCLE.

LOWER SIRAN RANGE.

Thinnings.

Compartment Name and Number.	Area.	Years in which prescribed for felling.	RESULTS OF OPERATIONS. 1923-24. Area thinned.	1923-24. Volume felled.	1924-25. Area thinned.	1924-25. Volume felled.	1925-26. Area thinned.	1925-26. Volume felled.	1926-27. Area thinned.	1926-27. Volume felled.	1927-28. Area thinned.	1927-28. Volume felled.	1928-29. Area thinned.	1928-29. Volume felled.	1929-30. Area thinned.	1929-30. Volume felled.	1930-31. Area thinned.	1930-31. Volume felled.	1931-32. Area thinned.	1931-32. Volume felled.	1932-33. Area thinned.	1932-33. Volume felled.
	Acres.																					
Baz Khan 1 (*ii*) ..	123	1923-24 1933-34	..	..	123	..	..	..	..		..	..	..	..	..	..	..	..	..	..	..	..
Tanglai 1 (*i*) ..	134	,,	..	..	134	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
,, 1 (*ii*) ..	126	,,	..	..	126	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Massar 10 (*i*) ..	64	,,	..	..	64	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
,, 11 (*i*) ..	214	,,	214	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Tanglai 2 (*i*) ..	153	1924-25 1934-35	..	..	153		..	..	..		..		..	..	..	..	..	..	..	..	..	..
,, 2 (*ii*) ..	128	,,	..	..	..	..	128	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
,, 2 (*iii*) ..	121	,,	..	..	..	..	121	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Massar 11 (*ii*) ..	216	,,	..	..	216	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
,, 9 (*i*) ..	236	,,	..	..	236	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
,, 9 (*ii*) ..	189	,,	..	..	..	..	..	..	189	..	..	..	..	..	..	..	..	..	..	..	..	..
,, 9 (*iii*) ..	219	,,	..	..	..	..	219	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
						× ×	× ×	× ×	× ×	× ×	× ×	× ×	× ×	× ×	× ×	× ×						
Tanglai 11 (*ii*) ..	187	1932-33 1942-43	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	187	37,727		
,, 11 (*iv*) ..	178	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	178	75,581	..	..
Batrassi 3 (*i*) ..	89	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	89	9,164	..	..
,, 3 (*ii*) ..	170	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	170	8,514	..	..
Massar 15 (*i*) ..	172	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	172	7,504
,, 15 (*ii*) ..	152	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	152	9,876
,, 15 (*iii*) ..	219	,,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	219	27,489
Total Acres thinned ..		..	214	..	1,052	..	1,568	..	1,389	..	1,216	..	1,178	..	608	..	1,425	..	1,453	..	1,039	..
Prescribed for the year ..		..	661	..	1,262	..	1,100	..	1,181	..	1,325	..	1,154	..	1,131	..	1,333	..	1,211	..	1,167	..
Balance forward ..		..	..	..	447	..	657	..	189	..	—19	..	90	..	66	..	589	..	497	..	255	..
Total area to be thinned ..		..	661	..	1,709	..	1,757	..	1,370	..	1,306	..	1,244	..	1,197	..	1,922	..	1,708	..	1,422	..
Deviation (Acres) ..		..	—447	..	—657	..	—189	..	+19	..	—90	..	—66		—589	..	—497	..	—255	..	—383	..

valuable than another, as in the case of deodar and fir, it is very desirable that the outturn of each species should be subject to control. In Kashmir this was done by means of a plus and minus account by species, a simple form for which is given at the end of this article (Form C.). It is rarely possible to prescribe a definite yield of each species to be felled each year, but this is a matter which requires watching and it is very much better to keep this side of the control separate rather than to try and incorporate it in Form 2-A.

In the North-West Frontier Province there are ten working plans to be controlled by the conservator, and for each of these the results of the work done up to date are being entered up in Forms A and B. The forms for all these plans will go easily into a foolscap register, which can remain constantly with the conservator on tour. For the conservator's control in the field nothing more is necessary and if these forms are sufficient for this purpose, why continue with anything more elaborate ?

FORM C.

PLUS AND MINUS ACCOUNT FOR SPECIES.

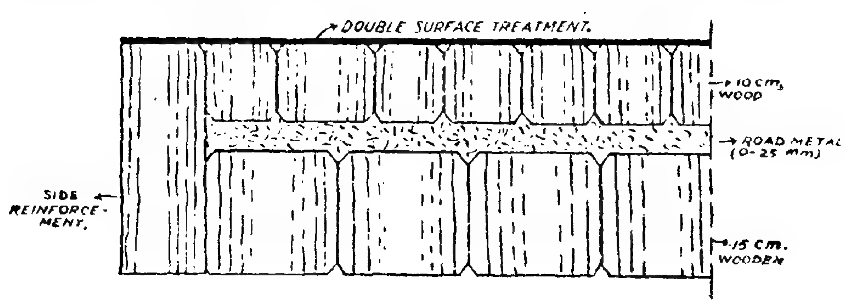
Regular Working Circle, *Working Plan.*

Year.		Prescribed yield for all species.	Normal Yield of		
			Deodar.	Kail.	Fir.
1923-24 ..	Yield ..	200,000	100,000	50,000	50,000
	To be felled ..	200,000	100,000	50,000	50,000
	Felled ..	210,000	120,000	30,000	60,000
	Deviation ..	−10,000	+20,000	−20,000	+10,000
1924-25 ..	Yield ..	200,000	100,000	50,000	50,000
	To be felled ..	190,000	80,000	70,000	40,000
	Felled ..	220,000	110,000	50,000	60,000
	Deviation ..	+30,000	+30,000	−20,000	+20,000
1925-26 ..	Yield ..	200,000	100,000	50,000	50,000
	To be felled ..	170,000	70,000	70,000	30,000
	Felled ..	170,000	120,000	40,000	10,000
	Deviation ..	Nil	+50,000	−30,000	−20,000

NOTES ON GERMAN DEVELOPMENTS IN WOOD UTILIZATION.

BY D. NARAYANAMURTI, M.SC.

Wood for Road Construction.—The German Forest Department has frequently undertaken experiments to find a suitable and economic use for cheap firewood whose disposal at present is not feasible. Generators for production of power gas for combustion motors have not as yet attained the expected result. Recently Dr. Deidesheimer has developed a new market for such wood in wood-stone paving. In this, green round wood of 5–15 cm. diameter, which is cut to lengths of 5–10 cm. is set in upright blocks to form the substructure on which road metal forms the surface covering. Till recently wood was used in roads in exactly cut rectangular blocks for surfacing. The experience with these wooden blocks has however not been everywhere equally good. The choice of suitable woods and their correct impregnation play a great rôle. Moreover such a road covering is costly. In the new process, according to which an experimental stretch has been constructed in Berlin, cheap and green firewood is the starting material of construction. The wood is cut in equal lengths at the place of construction and the sharp-edged wooden pieces are rammed in with road metal and rolled. Thus the road metal gets well pressed into the grooves and the sharp edges of the gravel bite into the wood. Thus a firm wood-stone covering is formed. The wood is impregnated with salts according to the "Osomose" process and hot tar emulsion is poured into the grooves and rolled.



As a final process for making the surface durable, tar-bitumen emulsion is once again poured along with gravel. Rolling now presses

the gravel into the surface of the wood. Thus a rough petrification of the wood surfaces takes place and with the addition of tar-gravel the preservation of the roughness and non-slippery characteristics of the wooden-road is effected. Where no road-metal is available or where the supply of wood is cheaper than that of road metal or cement, more wood can be used throughout. In order to protect the wood from decay the green wood is moistened and sprayed with impregnating salts before use. In the "Osomose" process only green wood can be used. This is advantageous because green wood prevents a later swelling of the wood in the pavement and hence cracking of the surface. Any shrinkage occurring afterwards can be remedied by filling up the grooves with tar-gravel.

The cost of the wood-stone pavement, according to the data of Dr. Ing. Deidesheimer, varies from 3·50 to 4·50 RM/m depending on the situation; for wood substructure only, 1·5 RM/m^2. The wood-stone-pavement can therefore be considered as a very cheap kind of pavement. The pavement should last about 20–25 years without costing much for its upkeep and also be equal to heavy traffic.—(V. D. I. *Nachrichten*, November 8, 1933.

* * * * * *

Preservation of Briquettes—In the preparation of charcoal briquettes starch, proteins, barley-flour and similar substances are used as binding material. To improve the binding power of starch and proteins milk of lime is usually added to the mixture of charcoal dust and flour at the suitable temperature. The briquette thus obtained is apt to get mouldy during storage, the place of storage usually being moist and the flour or similar binding material forming a suitable nutrient medium for the growth of moulds. Thus the mould will attack the binding material which will lose its binding capacity and the briquette will crumble to pieces. Dr. Gômôry of the Tech. Hochschule, Budapest (*Angewandte Chemie*, 1933, 46, 781) has carried out some experiments with a view to preserve the briquettes from mould attacks. The chemicals used for this purpose in addition to being cheap should not be poisonous to human beings on contact and

no harmful gases or vapours should be evolved while the briquette burns. Two ways are possible for application of such preservatives (a) addition of a suitable chemical to the charcoal—flour mixture prior to briquetting, (2) dipping of the briquette in an aqueous solution of the preservative. The latter method is considered to be more advantageous by the author as with the use of equal quantities, a lesser amount of the preservative per unit weight of the briquette is used.

As moulds are aerobic a surface layer of preservative is considered to be sufficient. The briquette is dipped for about 10 seconds in the solution of the preservative. Of the numerous chemicals studied a 5 per cent. solution of sodium pyroborate is considered to be the best.

*　　*　　*　　*　　*　　*

Fodder from wood.—Attempts to produce fodder from wood are very old. During famines branches mixed with bread and other things have been used as food. This use is also suggested by the fact that goats and deer use such material for nourishment. Braconnat in 1821 succeeded in converting cellulose to sugars by hydrolysis with sulphuric acid, the latest process in this direction being that of Bergius-Haggulund and Scholler.

The main thing to be accomplished to get a suitable fodder from wood is the removal of undigestible matter, chiefly lignin. This can be done by the reduction of cellulose. Lehman prior to the war showed that by digestion of straw with ammonia under pressure a good fodder could be got. During the war Beckmann showed that dilute sodium hydroxide without pressure transformed straw into a valuable fodder. But in the case of wood 40 per cent. sodium hydroxide is required, which is not desirable.

At the beginning of the war Haberlandt made a striking discovery when he noticed that very finely ground woody tissues were partially digested by ruminants. Digestion of raw fibre by sheep was also found to be not worse than that of medium quality hay. The difficulty in utilising this observation on a large scale is due to toughness and hardness of wood, to grind which extraordinarily great forces are

required. It was however noticed by Schwalbe that on treatment with hydrochloric acid gas, wood crumbles to fine powder between the fingers. Thus the cost of grinding may be cut down considerably. Fodder thus prepared however gave variable results with animals. This was traced to the presence of furfurol which inhibits digestion, though further experiments showed that if the process is carried out in a cold chamber about 50—60 per cent. of wood could be converted into a soluble form.

The next stage in the attempt was to try alkali hydrolysis with sodium hydroxide or calcium hydroxide. During the hydrolysis a partial neutralisation of harmful ingredients also takes place. In fact a loss of 10 per cent. in weight was noticed. Material thus prepared and ground swells well especially with addition of soluble sugars. Feeding experiments proved favourable. Cheapening of the process through addition of swelling agents suggests itself but the drawback with these processes is that with such addition the fodder cannot be kept very long. Treating wood with calcium hydroxide, grinding it with addition of sugar and then setting in a lactic fermentation (sauerkraut water) produced a fodder which kept satisfactorily but was not a good fodder. A pure biological process was also tried. Wood material after addition of sugar solution was ground and lactic fermentation then started. Feeding properties of fodder so prepared were good though not uniform owing to the difficulty of controlling a biological process. Finally use of only lactic acid was tried and was found to be good. The process as finally recommended is as follows: Wood in a green state is hacked to pieces without removal of bark. This is ground up with an addition of sugar up to 3 per cent. on the weight of wood, the mixture after addition of lime being left overnight. By the introduction of a hacking machine and an edge runner for grinding and mixing the cost of production is made very cheap.

The main claims of the investigation are that (1) Wood fibre can be made more digestible without removal of lignin. (2) Digestibility of the fibre of about 60 per cent. which corresponds to that of good wheat hay can be attained by alkali hydrolysis in combination with

swelling agents like carbohydrates and by fine grinding. (3) By allowing wood to swell with help of carbohydrates and setting in a lactic fermentation a digestibility of 63 per cent. is attained. (4) A digestion of 77 per cent. is also attained through swelling or maceration with lactic acid alone. (5) The digestibility of the nitrogen-free extractives in (3) or (4) can be as high as 100 per cent. (*Angewandte Chemie*, 1933, 46, 707).

REVIEWS.

THE FAUNA OF BRITISH INDIA, DIPTERA.

Vol. IV, Family CULICIDAE, *Tribe* ANOPHELINI, *by Bt.-Col. Sir S. R.* CHRISTOPHERS, *C.I.E., O.B.E., F.R.S., London, October*, 1933, *pp. i - vi,* 1—371, 53 *figs.*, 3 *plates.*

The latest volume of the *Fauna of British India* provides an up-to-date account of a much studied group of insects, the mosquitoes of the tribe Anophelini, commonly known as the Malarial Mosquito, Anopheline mosquitoes, Anophelines or Anopheles. There are 43 species of Anophelini in British India of which five species, *Anopheles culicifacies, A. stephensi, A. minimus, A. fluviatilis* and *A. sundaicus* are important carriers of malaria wherever found. There are two other species that are proved carriers in some areas but of less importance and there are various other species that have been found infected in nature or experimentally within or outside British India, but which, for various reasons, are of no importance as carriers. The extremely common species *A. subpictus* and *A. vagus* appear to have little or no relation to the incidence of malaria.

The preparation of a monograph of the Indian Anophelini could not have been in better hands than those of Col. Sir. S. Christophers whose long and close connexion with the study of the taxonomy and biology of mosquitoes is well-known. This book is an unusually successful survey and summary of his personal investigations and of those of his colleagues in the medical services and research institutions. The choice and arrangement of the subject matter is marked by considerable originality of treatment which sets a new standard in the *Fauna of British India* series for groups of economic importance.

The systematic part, dealing with the characters of the generic groups and series, with the species and varieties, occupies nearly two-thirds of the book but is a marvel of condensation of essential data. In addition to a detailed illustrated account of the adult characters used in identification and classification, the characters of the egg, larva and pupa are discussed almost as fully with extensive keys.

Other sections deal with geographical distribution, phylogeny, bionomics and relation to disease, bibliography, etc., and there is a valuable section on the technique of collection, rearing, and preservation that bears the unmistakable stamp of medical research.

We hope that the appearance of this book will stimulate forest officers to collect and identify anopheline mosquitoes in the still unworked forest districts, where so many rest houses, range quarters, and guards' houses have acquired reputations for being malarious without a scrap of evidence as to the existence or absence of carrier species.

C. F. C. BEESON.

A FOREST FLORA FOR PILIBHIT, OUDH, GORAKHPUR AND BUNDELKHAND.

By P. C. Kanjilal. Allahabad, 1933. Price Rs. 10/-.

The author in this book has made a laudable attempt in giving a resumé of the general features of the vegetation of the areas mentioned. Synopsis of the families, glossary of botanic terms, index of families, genera and species and index of vernacular, Sanskrit, Persian and Arabic and English names have been added. Generic and specific keys and short but definite descriptions, ample field notes most of which have been compiled in the field and subsequently confirmed by comparison with authentic sheets in the Calcutta and Dehra Dun and Shillong herbaria are useful additions to the Flora. Although the author mentions almost all the forest trees of the districts specified, the herbaceous and shrubby representatives of the forest floor vegetation have not escaped his careful attention and the chief representatives have been noted as far as could be accommodated in this handbook. The Flora, although particularly meant for the needs of foresters, fulfils a long felt want in the compilations of the local Indian Floras and is equally useful to botanists and amateurs at large.

K. BISWAS.

CHANGES IN THE CELL CONTENTS OF WOOD (XYLEM PARENCHYMA).

And their relationships to the respiration of wood and its resistance to Lyctus Attack and to Fungal Invasion.

BY S. E. WILSON, M.SC., PH.D., D.I.C.

(*The Annals of Applied Biology, Vol. XX., No. 4, pp.* 661-690, *November*, 1933).

This paper gives the results of an intensive study made on the starch contents of timbers which have been felled. The history of the starch contents of converted timber has great economic value, for amongst the wood destroying agencies many insects and fungi are usually dependent for their food on the reserves of food materials present in the wood.

The author started the experiments with small branches of oak, ash and other trees. He found that quick drying resulted in the retention of the starch, while by a slow drying process considerable depletion of starch could be brought about. The results of these experiments were verified with some big pieces of timber, and the author came to the conclusion that it would be possible to eliminate completely starch from sapwood, provided the process of drying was delayed to enable cell activities to continue long enough to exhaust all starch reserves. He then studied the factors which influence the time required for starch depletion. The results showed that while drying a log to starch-free condition by sealing its ends, the time required for starch depletion would depend on a number of factors, such as the species of the tree, the dimensions of the log, the initial amount and distribution of the starch, and the weather conditions. Further the author found out that in the case of commercial timbers, if logs were converted shortly after felling and treated in any way to cause the early death of wood parenchyma cells, the initial quantity of starch remained in the sapwood. On the other hand, he found that the starch completely disappeared from small logs which had been stored under cover for twelve months before conversion. These logs were, however, kept under observation during the year and

it was noted that starch depletion took place gradually from the bark inwards and more rapidly for the first four of five months than later. Some experiments were also carried out on seasoning by immersion in water. In this case, the rate of starch depletion from the wood parenchyma cells appeared to be the same as for a sealed log in air, provided the logs are immersed immediately after felling, otherwise the cells die and the starch content does not undergo a depletion.

Experiments were also done to find out the relation of the starch to *Lyctus* attack, and it was found that starch depletion rendered ash sapwood immune to *Lyctus* attack. Thus the author offers a simple and inexpensive solution of the problem of *Lyctus* attack. On the whole the paper shows a thorough and intensive piece of research work, and the author should be congratulated for bringing it to a successful completion.

K. A. C.

FOREST RESEARCH ON AN IMPERIAL BASIS.

1. *Grading Rules and Standard Sizes for Empire Hardwoods.* (Price one shilling, post free from Director, Imperial Institute, London, S. W. 7).

A pamphlet bearing this title has recently been issued by the Imperial Institute to all imperial and colonial governments giving tentative grading rules drawn up by the Advisory Committee on Timbers and recommending that these rules should be used in commerce and their practical utility tested. They have already been approved by the Timber Trade Federation of the United Kingdom, so will automatically become operative on all consignments of timber reaching the home market, and this fact alone should ensure their adoption by all timber firms and departments who contribute to the home timber supplies. The rules are exceedingly broad and reasonable and should cause no hardship whatever to colonial exporters but the committee particularly wish to be given observations on the working of these rules by forestry departments, shippers, merchants, and timber users. Provincial governments in India are being asked

to institute enquiries, including mill studies, into the percentages of material of the different grades which can be produced from average logs of various timbers exported.

2. *Forest Products Research Board Report*, 1932.—The following is an interesting extract from the Department of Scientific and Industrial Research resumé of recent developments in this sphere :—
"We have laid stress on the importance of the work carried out at Princes Risborough, but it is work which forms only a part of any scheme for promoting the marketing of Empire timbers, and by itself could achieve little. The investigatory work in the laboratory provides only the middle link in a chain of three which connects the forest in the Empire Overseas with the timber user in the United Kingdom. The three links are—

(*a*) information about species and prices: this requires survey work in the forests of the producing area and a study of the transport costs ;

(*b*) information about the qualities of the timber: this is furnished by tests such as those carried out at Princes Risborough ;

(*c*) marketing promotion: this requires suitable marketing machinery in the United Kingdom which must form direct contacts with the producing areas, and in the case of the colonies assist them to organise the development of their supplies."

"We feel it incumbent on us to take this opportunity of reiterating our views, so that with the disappearance of the Empire Marketing Board, whose sphere of work covered all three of the links, there may be no failure to provide adequately for the first and third of them no less than for the second. To continue the work of Princes Risborough on Empire timbers without proper intelligence concerning supplies would be to build a house without foundations. To do so without a proper marketing organisation would be to build one without doors and windows."

That both the points emphasised are being attended to is shown by the efforts now being made by Princes Risborough to send experienced representatives on colonial tours and to give selected colonial forest officers courses in training in market requirements when they are home on leave. This is a lesson which we in India should take to heart, for one of the worst effects of recent economies has been to discourage our Forest Economist and his staff from touring and also to restrict the visits of territorial officers to Dehra Dun.

A standard method of determining the natural durability of timbers in comparison with English oak is being developed by exposing specimens of heart and sap wood to the attack of wood-destroying fungi. The resistance to attack offered by the timber is determined from the loss of weight suffered by a specimen after a known period. Amongst the great variety of other points dealt with in the report are the new "bad construction" and "good construction" rooms for testing building design as affected by wood rots; the chemistry of decay in wood; an increased public interest in timber beetle damage is noted; sterilization of wood against beetle attack by kiln seasoning, combined air and kiln seasoning, the steam bending of wood, and panelling experiments all show the close parallel development between Princes Risborough and the Economic Branch at Dehra Dun.

3. *Imperial Forestry Institute Report*, 1932-33.—Lack of funds has led to enforced economies in the organisation of the institute, the most serious being the abolition of the post ot secretary. This seems to be particularly unfortunate in view of the constant increase in both the quantity and scope of the advisory problems which now come in from all parts of the Empire. There was a considerable reduction in the number of students, partly owing to the check in recruiting and partly owing to governments economising by refusing study leave to officers already in their service.

A good example of team work is reported in the work on the cricket-bat willow. A conference of growers and others interested was called by the Forestry Commission and as a result three officers of the institute made an extended tour of the willow districts during

the flowering period. Growers and buyers of bat-willows complain of the high percentage of trees which give unsatisfactory wood, and of the waste found in otherwise good trees. The main causes of this appear to be (1) the planting of male trees and of wrong species and varieties of female trees, (2) improper or careless treatment of nursery sets, (3) neglect of young trees after planting, (4) the effect of unsuitable soils and unfavourable situations, (5) planting the trees too closely, (6) injury from 'watermark' disease, 'stain,' and 'speck'; the last named has been attributed to an insect, but requires further investigation.

Cuttings of trees tested by the Forest Products Laboratory, Princes Risborough, are being grown from which it is hoped to produce pedigree stocks whose qualities as bat timber can be guaranteed. Phenomenally rapid growth is reported from hybrid seedlings of bat-willow.

A great deal of useful botany and wood technology research has been carried out, chiefly on African tree species. A piece of a coffin from an Egyptian coffin of 3,000 B. C. was found to be made of ply-wood. So much for our much vaunted modern discoveries! Other timber from ancient tombs was of cypress, cedar and tamarisk, elm from a chariot wheel, and *Zizyphus* from a walking stick.

Pathology covered a wide range of problems including the effects of frost and the anatomy of frost injured trees. A further outbreak of the "ink fungus" on sweet chestnut has occurred and from inoculation experiments it is thought that the Japanese chestnut *Castanea crenata* will provide a highly resistant substitute species.

In connection with the damping off of seedlings various fungicides are being tried. So far no fungicide has proved to be absolutely reliable but it is hoped that others now under trial may prove more effective. As in Dehra Dun a steady increase is reported in the number of enquiries on mycological questions from outside enquirers.

An investigation that should be of considerable value to Indian foresters is that on the causes of loss in conifers from butt-rot, that is heart-rot entering the tree through a decayed root. Steps are being

taken to determine the fungi responsible and to collect data as to the soil conditions where the samples are collected, in order to correlate the systematic work with the ecological conditions in which attacks occur.

Entomological research centred mainly on the attacks of the *Evetria* pine shoot moth on Scots pine in East Anglia and oak tortrix moth in the Forest of Dean.

R. M. G.

INVESTIGATIONS ON THE INFESTATION OF *PERIDERMIUM HIMALAYENSE* BAGCHEE ON *PINUS LONGIFOLIA*.

Part II. Cronartium himalayense n. sp., on Swertia *species, distribution, morphology of the parasite, pathological study of infection, biological relationship with the pine rust, and control.*

By K. D. Bagchee, D.Sc., Indian Forest Records, Bot. Ser. 18 : pp. 1-66 : 1 *coloured frontispiece and* 17 *plates*, 1933.

This is the second and more extensive part of the author's investigations on the blister rust of Himalayan pine, *Pinus longifolia*. In an earlier publication he had shown that the stem form of blister rust, considered by Barclay as a variety of *Peridermium orientalis* Cooke, was a distinct species and had named it *P. himalayense*. The discovery of the alternate host on species of *Swertia* is reported in this paper. The genus *Swertia* belongs to the family Gentianaceae and, so far, the author has been able to show that five species are host to the *Cronartium* stage, of which *S. angustifolia* seems to be the chief source of danger to the pine forests. The uredinial sori lie on the

under surface of the leaf in the form of round patches and the telial sori arise from the old uredinial sori. In the course of one year five or more crops of urediniospores followed by an equal number of crops of teliospores may be produced, the former being the repeating phase. This stage has already been named by Sydow *Uredo opheliae.* According to Art. 49 (bis) of the International Rules of Botanical Nomenclature the perfect state in the Uredinales is the teliospore stage. Generic and specific names given to other stages have only temporary value and cannot replace existing names. The name of this blister rust should therefore be *Cronartium opheliae* (Syd) Bagchee (Art. 48 of the International Rules) and not *C. himalayense* which together with *P. himalayense* merges into synonymy.

The author's experiments on germination of seeds of *Swertia* showed that they have a long dormant period. Possibly if he had tried to 'stratify' the seed as is done in the case of coniferous seeds and had also used year old seed, he might have got better results. Inoculation with aeciospores (from pines) gave the *Cronartium* stage on *Swertia alata* and *S. angustifolia* and from the fact that check plants remained free from infection, one is led to conclude that the two stages are genetically related and are of the same rust. Absence of green-house facilities did not evidently permit more rigorous tests and the author did not find Clinton and McCormick's Petri-dish method of infecting *Swertia* leaves quite successful. Waters' modification of that method might have given better results as more delicate leaves than those of *Swertia* have been successfully infected by him. High humidity, low temperature and shade contributed towards successful inoculation and histological studies showed that the entry was through stomata. Both the urediniospores and teliospores were viable for a short time. There is no record however of any tests conducted to see the infection of the *chir* pine by the sporidia from *Swertia* and these together with experiments to find out whether the resistant varieties maintained their resistance under controlled conditions would have added to our knowledge. In the section on 'Weather conditions in relation to *Swertia* infection' observations like 'warm foot-hills,' 'high humidity,' and 'low temperatures' lose much of their significance in the

absence of exact figures and on page 29 the Fahrenheit and Centigrade scales have been mixed. It would have been advisable to stick to one scale. Twenty pages have been devoted to 'General considerations' and 'Control methods' and one gets lost in the maze of speculati . in which the author has indulged. A few direct hints based on act al experiments to control the disease would have been preferable to the mass of hypothetical recommendations.

Elimination of some of the speculative statements regarding control and climatic factors where much repetition also occurs would have brought down the publication to reasonable proportions, enhancing its value. The author has measured five hundred each of urediniospores and teliospores from different species of *Swertia.* The mycologists have now become statistically minded and a biometrical analysis of the data would have been interesting. Indeed one of the earliest investigators to introduce biometry in mycological work was Colley, cited by the author, and the fungus he used was a *Cronartium.*

At the Cambridge Botanical Congress held in 1930 it has been definitely laid down that all descriptions of new fungi, after the 1st of January 1933, should be accompanied by a Latin diagnosis. The author has not done so and on this ground also the new name given by him is invalid. This the author will have to supply and at the same time amend the name of the fungus.

M. and M.

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Notes by the author.

1. Cooley has entirely relied on simple average in spore measurements in the paper in which he has described *Cronartium ribicola* and worked out the morphology of the fungus (Colley, R. H—Parasitism, Morphology and Cytology of *Cronartium ribicola,* Journ. Agri. Resch., Vol. XV, No. 12, p. 619, 1918). But where he has reasons to believe that this fungus may overlap with other *Cronartiums* existing in the same region and having the perfect stage on the members of the same genus *Ribes* and the aecidial stage on different pines, he has

resorted to statistical methods in spore averaging and also to biometric comparison (Colley, Hartley and Taylor,—A Morphologic and Biometric Comparison of *Cronartium ribicola* and *Cronartium occidentalis* in the Aecidial Stage, Journ. Agri. Resch., Vol. XXIV, No. 6, p. 511, 1927). With *Cronartium himalayense* it has been mentioned (Introduction, p. 4) that where this fungus exists, there are no other stem *Peridermiums*, so that simple averages from a large number of spore forms should be sufficiently reliable.

2. "Warm foot-hills," etc., are used as comparative terms; a definite determination of these data would mean the establishment of permanent research stations in the regions surveyed and experiments conducted, as in the Wheat Rust Research Laboratory at Simla. But this was not within the scope of the project. In fact, the experiments were conducted with the simplest field equipment in various forest rest-houses and in camps during marches.

3. The successful inoculation on *chir* with sporidia from *Swertia* has been briefly alluded to (p. 40) and aecidial spore formation has recently been noted. The details of the experiments will form the subject of another paper, when completed, but unlike the wheat rust, where the whole cycle is completed within a year, it takes from four to six years to reproduce the aecidial stage on pine.

4. The International Nomenclature or "Vienna rules" have been referred to by the reviewers. They have agreed that *Uredo opheliae* Sydow refers only to an imperfect stage, but propose retaining the specific terminology "*ophelia*" though this is actually an obsolete name for *Swertia*. To justify replacing the old synonym *Uredo opheliae* Sydow, by *Cronartium himalayense*, the author wishes to quote the following extracts from letters of Dr. E. J. Butler, Director, Bureau of Imperial Mycology, Kew, on the subject:—

(i) Dated 18th March 1930.

"The position, therefore, is that the aecidial stage of this fungus has been named *Peridermium himalayense* in 1929, and its uredo stage, *Uredo opheliae* in 1903, but the perfect (*i.e.*, teleuto) stage has not yet been named."

"Under the Vienna rules of botanical nomenclature you can neglect the earlier names when naming your *Cronartium*, as they were only applied to imperfect stages. But you would be following the practice of prominent American rust systematists like Arthur in keeping to the oldest names and calling it *C. opheliae*. So far as we can discover this combination has not previously been used for any plant."

(*ii*) Dated 10th June 1930.

"Of the names for your new *Cronartium* suggested in your letter D. O. No. 578 I would personally prefer *C. himalayense*. *C. swertiae* is ugly and *C. opheliae* rather misleading as the genus has been reduced. But as I said before, you are perfectly free to choose any name you like."

6. The Latin description of the fungus has been left out as it can more suitably find its place in a technical journal on mycology.

K. D. B.

EXTRACTS.

MANUFACTURING TEA CHESTS.

The packing of tea must, from time to time, give cause for anxiety to those responsible for shipping the huge crop from Northern India to all parts of the world, as under present conditions five-sixths of the box requirements of the trade are still imported from the continent of Europe which, to say the least, is in a most unsettled state and the future seems obscure.

In the early days of manufacture all tea boxes were made locally on or near the gardens from *simul* or other softwood timbers and as the industry grew supplies were supplemented by plank boxes from Japan, the best known being the " Momi " box ; because these local boxes were made from unseasoned wood, the shooks merely being sun-dried, a very heavy, and, therefore, expensive, four-ounce lead lining had to be used to guard against " taint " from the unseasoned wood.

So recently as 1919, several lakhs of these boxes were still in use and many saw-mills were fully employed on the banks of the rivers from Sylhet to, as far north as, Saikwa ; the sizes of these mills varied—the largest turning out as many as three lakhs in a season, and the smallest only a few thousands. These mills employed many thousands of men and hundreds of elephants for dragging logs of wood and the Government of Assam naturally benefitted to a large extent from the royalty on timber. There were two mills in Sylhet and one mill each at Tezpur and Badati ; another at Dehingmukh and Bordeoban. Four mills were fully employed near Dibrugarh, two near the town itself and one at Sissi and another at Laimakuri. There was also a small mill at Saikwa. All these mills have since been closed or have disappeared because of the demand for the more popular and more economical 3-ply box with its easier handling and very light lead or aluminium lining.

It was during the great European War that the tea industry was concerned with having to get its supplies from the continent, prices rising as high as 10 sh. c.i.f., Calcutta, for the standard 19 by 19 by 24 chest. Considerable difficulty was experienced in meeting the demands of the industry, so much so that in 1917, at the request of the Munitions Board, the Surma Valley Sawmills, which was then manufacturing country shook plank boxes, undertook the manufacture of 3-ply boxes and obtained a first class Certificate of Priority for the import of the necessary plant. This venture was not a success partly owing to the difficulty of obtaining, under war conditions, suitable raw material for the class of cement required and partly to the lack of suitable timber in sufficient quantities. This company was the pioneer of plywood manufacture in India and experience soon showed that although most timber will veneer, not all timbers are suitable for boxes. Two years later the Assam Sawmills and Timber Co., Ltd., was floated with its six sawmills then manufacturing country shook boxes. It was granted a 30-year lease for the extraction of timber from the North-East Frontier tracts provided it erected an up-to-date veneer factory within two years. This undertaking was achieved and a magnificent performance it was, showing, as it did, that the indomitable spirit of British engineers still lived. On a large " chapri " on the north bank of the Brahmaputra river, some 20 miles north-east of Dibrugarh and some 25 miles from the North-East Frontier of India, with only river communication with Dibrugarh and served by a small feeder steamer, a huge factory was built at Murkong Selek. Engines and machinery were installed, bungalows and coolie lines were erected and this was accomplished within two years. Whilst the work was proceeding a large herd of elephants was procured for dragging logs of wood and a light railway was laid down, with the necessary bridges large and small and pushed out twelve miles through virgin jungle to tap the enormous forests allotted by Government to the company.

The difficulties at first were great and the undergrowth in this Assam forest was so thick that even an elephant could only push its way through at a pace of one mile an hour.

This veneer mill, at that time only the second to work in India, was equipped to manufacture five lakh boxes annually. The company for several years passed through an anxious time. Gradually each of its six mills was closed due to the disappearance of the demand for the now old-fashioned country shook-box and so to-day the veneer mill only remains working and sells its outturn, in increasing quantities, to most of the leading tea firms in Calcutta and London.

In 1924 yet another veneer factory was installed, a plant having been erected by the Assam Railway and Trading Co., at Margherita on the Dibru-Sadiya Railway and this is working at the present time.

It is understood that although these two remaining factories can and do compete in price with the imported chest, neither factory finds it easy to sell its full outturn owing to the many vested interests in foreign boxes. There are to-day at least eight different boxes being imported from Europe, all of which are marketed by firms interested in tea.

It is correct to say that in normal times thirty lakh chests are required by gardens in Northern India and that factories manufacturing in the heart of the tea gardens

find it difficult to dispose of five lakhs. It is a matter of opinion whether those responsible for packing this enormous tea crop are wise in relying upon European shippers for packing and despatching their very valuable produce and it would seem a short-sighted policy not to support this local box industry to the full with the object of encouraging other companies to manufacture tea boxes in different parts of Assam, until at least 50 per cent. of the trade's requirements could be bought locally. That the raw material is in India and available is proved by the Report of the Tariff Board which investigated the condition of the industry in 1927, when it visited the plywood factories then working and the forest from whence the mills secured their raw material. That India can produce a sound and economical veneer tea box has been proved in practice and that over a period of years, and that the Indian 3-ply box is a good one, is also proved by the fact that the sales of the indigenous chests are slowly but surely rising. Whether those interested in this industry are sufficiently rewarded for their trouble is another matter and one that need not be discussed here, but with prices such as they are to-day, due to dumping of plywood from the continent, it is doubtful if the industry can flourish without greater support from the tea trade. To show with what the indigenous industry has to compete it is interesting to quote an extract from the Report of the Indian Tariff Board of 1927:—"The pre-war price of a Venesta Chest of these dimensions (19 by 19 by 24) was Rs. 2-14 f.o.r., Calcutta. If exchange is taken at the current rate of 1s. 6d. = Re. 1, this would be the equivalent of Rs. 2-8-9·6 or excluding duty, which then stood at 2½ per cent. Rs. 2-7-9·6; the current price of a Venesta Chest has been stated to be Rs. 3-6 f.o.r.; excluding the duty this would be reduced to Rs. 2-14-9."

To-day, six years later, the price of a 19 by 19 by 24 box f.o.r., Calcutta, with an import duty of 23 per cent., is about Rs. 2-6 f.o.r., Calcutta, that is nearly 3 annas under the pre-war price and with an import duty of 25 per cent. against 2½ per cent. in 1914.

It may be asked how this has come about and the answer is not a difficult one. In Europe, in such countries as Russia, Finland, Austria and Jugo-Slavia, there are many veneer factories manufacturing plywood boards, not for tea boxes but for panelling, furniture and all sorts of building work. Very large panels are made up to 6 ft. by 6 ft. and in the course of manufacture there are millions of small panels automatically outturned, not large enough for the general trade but admirably suited for tea boxes. Tea box panels, therefore, can be classed as waste or bye products of these factories and so can be dumped very cheaply into India.

India can produce tea boxes almost entirely of Indian materials. In fact, everything that forms part of a tea box can be procured in India with the exception of tin for the manufacture of tinplate for the fittings and a few alkalies for the manufacture of cement.

It is the policy of most countries of the world to-day to buy their requirements from within the country rather than from without. If the tea box industry was correctly supported, hundreds of unemployed in Assam would benefit, large sums of money would remain in India to the advantage of India and in the event of a world crisis, tea gardens would be assured of being able to pack their crop.—(*Capital Indian Industries Supplement, December* 1933).

INDIAN FORESTER.

MAY, 1934.

THE MEASUREMENT OF SOIL FERTILITY.

The study of the chemistry and physics of agricultural soils has been greatly advanced in recent years through an increasing knowledge of the clay fraction of the soil, and of the colloidal substances which give clays their peculiar characteristics. Clay is now regarded as being analogous to a salt, being made up of basic and acidic portions. Clay can interact with salts to form new clays differing from the original in just the same way as the salt of one metal differs from the salt of another metal. The forces which combine the acid and basic halves of the clay, and the forces which attract or repel the whole clay particle in its relation with other soil contents, are now being studied from new angles, and the tendency is for the old-fashioned strict classification into chemical, physical, and electrical to be broken down because these can no longer be treated as separate phenomena.

The recently received reports of the Rothamsted Experimental Station for 1932 and of Agricultural Operations in India 1929 to 1931 both bring this point out very clearly, but they also show that the agricultural soil specialists are very much behind-hand in their practical application of clay "doctoring" compared with similar manipulations in manuring. At Rothamsted they have proved that the fertility of the soil depends largely upon the "crumb structure" and the stability of the crumbs of a clay towards water. Crumbs that will persist when moist are much more conducive to productiveness than crumbs which break down readily, and this stability depends upon the colloidal structure of the clay particle. Calcium clays are more stable than others, but stability in all types is enhanced by the action of micro-organisms such as bacteria, apparently through the formation of a colloidal film on the surface of the clay particle. Crumb formation

occurs in the first place from interaction between the clay molecules and the water present, and this apparently depends upon the electric moment possessed by the molecule.

Workers at Pusa regard the soil particle as a colloidal tribasic acid unit with three replaceable surface-active hydrogen atoms, the flocculation capacity of the various soils depending upon the nature and degree of these hydrogen atoms which are electrically charged and are exchangeable with other similarly charged salts. Bacterial activity and the health and growth of plants are directly dependent upon the degree of saturation of the soil colloid. Nitrogen fixation, which is such a vital process in the maintenance of soil fertility, is interfered with when the soil colloid remains unsaturated, and normal growth can apparently take place only when the hydrogen ions of the soil particle are neutralised. In Burma it has been shown that certain soils which are useless for irrigation bunds because they are so easily washed away, owe this character to the large amounts of replaceable sodium in their clay complex. Again in the *kalar* salt lands of Sind and elsewhere, injurious sodium salts are commonly present in such large quantities as to reduce the nitrogen-fixing power of these soils; efforts in reclamation of such soils must obviously be towards the restoration of the neutral balance which allows the nitrogen fixers to work. This can be accomplished in a variety of ways:—growing deep-rooted leguminous crops such as *berseem*, deep ploughing to improve the drainage, holding up flood water by means of bunds and mixing gravel with the soil, application of sulphur and farmyard manure as in the rice-growing areas of South India, and the application of gypsum to the *kalar* lands of the Punjab. All of these have been tried and have given encouraging results.

The routine methods of soil analysis generally in use are exceedingly laborious and lengthy. As a matter of interest to forest officers, we give below the details of the method in regular use in the Chemistry Branch of the Forest Research Institute for all soil samples submitted, just to show what a lot of work is entailed for each sample :—

20 grams of air-dried soil which has been sieved through a 2 mm. sieve to remove fine gravel is heated in a tall 400 c.c. beaker with 6

per cent. hydrogen peroxide to ensure thorough dispersion of finer particles. The soil solution is then transferred to a 100 mesh sieve and rubbed through into a litre bottle. The coarse sand thus separated is dried in a tared basin at 105° C. and weighed ; while the solution is made up to 500 c.c. in one per cent. ammonia. The bottle is given end over end shaking for 24 hours, after which it is emptied out into a measuring cylinder, the total suspension being made up to one litre. The suspension, after repeated inversion of the cylinder, is allowed to stand 4 minutes 48 seconds and sampled at 10 cms. It is dried at 105° C. weighed, and percentge of silt-plus-clay calculated. The contents of the cylinder are again shaken for one minute and allowed to stand for 8 hours, after which clay is sampled at the same depth of suspension *i.e.*, 10 cms. dried, weighed, and percentage calculated. The difference of this from the first reading gives the percentage of silt. All the finer fractions from the suspensions are removed by repeated decantation using a depth of 10 cms. and time 4 minutes 48 seconds, and the fine sand is left behind, which is then dried, weighed and percentage calculated.

The depth of 10 cms. is based on a temperature of 20° C. In order to correct for the changes in viscosity of water with temperature the depth is changed accordingly :—

Temperature C.	..	15° C	20° C	25° C
Depth in cms.	..	8·8	10·0	11·25

In a paper on "The Physical Properties of Hawaii Soils" (*Hawaii Agric. Experiment Station Bull.* No. 62, 1931) C. Richter gives an interesting comparison of the various methods tried in analysing the colloid content of tropical laterites, whose fertility varies largely according to the stage of reduction of their organic contents towards a fine silt or even smaller particle. Mechanical analysis by rubbing, shaking, and electric stirring proved useful up to a point in obtaining "dispersion" of the finer fractions, but chemical analysis to stabilize the dispersed colloidal particles gave very varied results. Others such as the water vapour absorption method, recommended by previous workers, were tried but the author's conclusion is that "with a highly heterogeneous substance such as soil, possessing a number of

compounds both organic and inorganic in widely varying proportions, not only in different soils but sometimes in the different fractions of the same soil, the expression of a certain physical property in terms of particle size may sometimes become misleading." The method he found to give the most practical results was by taking hydrometer readings of soil samples which had previously been dispersed in an electric stirrer. The dispersed soil is made up to a definite volume with water in a glass cylinder, and after the required settling time the density of the soil suspension is read by means of a hydrometer at a fixed temperature. This reading divided by the weight of the soil used gives the percentage of the fraction in question.

TAUNGYA CONFERENCE.

A Conference of U. P. forest officers interested in *taungya* plantations was held at Naini Tal from 31st August to 2nd September 1933. We have much pleasure in reproducing the address of the Chief Conservator, Mr. F. Canning, and two of the very interesting illustrations accompanying the reports of the proceedings. (Copies of the printed report are available from the Conservator of Forests, Working Plans Circle, Naini Tal, (U. P.).

During the last few years very great progress has been made with artificial reproduction in the U. P. due to a great extent to the failure of natural regeneration of *sal* to establish itself in a reasonable time. Recent developments in forest management have forced the department to take up the development of *taungya* on a large and increasing scale both for the regeneration of the *sal* forest and also for the conversion of the large areas of miscellaneous forest at present of very little value into plantations of species such as *Acacia catechu* and *Bombax malabaricum*. Our two illustrations (Plate 27) show firstly a cutch plantation in the first *rabi* growing with wheat and in the background will be seen the class of more or less worthless miscellaneous forest of Haldwani being converted into plantation, and secondly a teak plantation 7 years old in the Gorakhpur division where *taungya* was first started in the U. P. nearly 15 years ago on account of the failure of *sal* coppice.

Taungya in the first rabi. *Khair* in lines with wheat. Valueless miscellaneous forest of Haldwani division being converted into valuable *khair* plantations.

A teak *taungya* plantation 7 years old, Gorakhpur division.

Very great progress has been made in this branch of forestry and in view of the fact that the department has a lakh of acres of miscellaneous forest in the U. P. at its disposal and capable of being enormously improved by *taungya* plantations, the scope for work of this class is very great. The Working Plans Circle is wisely considering to what extent a market exists for species other than *sal*, so that the area to be planted may be regulated to avoid over production.

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"GENTLEMEN,—I have much pleasure in opening this Conference and in welcoming so many officers to it. You already have the agenda before you and can see that there is a considerable amount to be discussed and I therefore do not wish to make my opening remarks any longer than necessary.

I found on return from leave this spring that *taungya* had made a remarkable progress in the comparatively short time that I had been away and that there was a general desire that an opportunity should be arranged for officers to meet to discuss the subject. I therefore convened this Conference.

I should first like to deal with the importance of our subject. Owing to the need for reduction of expenditure our present policy is to limit artificial regeneration work to what is necessary to replace existing growth of trees. The success that is being attained enables the rate of fellings to be accelerated and, where natural regeneration is not obtained, this artificial work is steadily being extended and experience is now justifying prescriptions for fellings based on replacement by artificial regeneration. One of the most important developments of the last two years is the rapid expansion of *taungya* (the combination of field crops with the sowing of forest trees). While meeting the wishes of cultivators near forest tracts this enables the raising of forest crops with the minimum of expense, hence while the acreage of artificial reproduction is rapidly increasing, the cost is by no means rising at a proportionate rate.

Taungya was started in the Eastern Circle in Gorakhpur and has extended to the Bahraich and Gonda Divisions as a regular feature. In

this Circle at the close of the year 4,216 acres were under *taungya* cultivation. In the Western Circle it was started regularly in Saharanpur Division where 121 acres had been taken in hand up to 1931-32, it has since expanded in this division in subsequent years to 186 acres in 1931-32, 376 acres in 1932-33, and for the coming year arrangements have been made for 470 acres. In this Circle it has also become a regular feature in the Haldwani, Ramnagar, Lansdowne and Dehra Dun Divisions, and the total area taken in hand in the Circle in 1931-32 was 264 acres, in 1932-33 it rose to 736 acres, while the acreage for the coming year will probably be over 1,000 acres.

The system is applicable to many classes of forest ranging from good *sal* forest to poorly stocked grazing grounds. In the latter trees valuable for lopping for fodder can be introduced with trees giving a light shade but having a value for their timbers such as *khair* and *semal*, and grazing grounds can be not only improved for the cattle but also made more remunerative. The system involves the display of tact with the cultivators and much strenuous work at times when the forests are far from healthy. The results noted above have only been obtained by the intense keenness and hardwork of all ranks from the higher staff to the subordinates concerned.

Now to emphasize the importance with which I view the progress of our artificial regeneration work from another and most important aspect, I would like to refer briefly to the financial results of the Department. You already all know the position to the end of 1931-32 which is given in the report already issued. In the past year our surplus rose from Rs. 18,85,000 to Rs. 20,66,000, an increase of Rs. 1,81,000 composed of Rs. 30,000 increase of net revenue and Rs. 1,51,000 reduction in indirect expenditure. The increase in net revenue occurred in the Western Circle where incidentally the development of artificial regeneration has simultaneously been a most marked feature. The decrease in expenditure is distributed generally in all circles. It comes very largely under the head of establishment, mainly reduction in salaries, which may be classed as personal sacrifices and reduction in staff partly from less work in progress and partly from giving a smaller staff more work to do. But there is also a substantial

reduction of Rs. 38,000 under "Conservancy and Works" of which Rs. 22,000 is under sowing and planting. This latter is partly due to work being limited to what is necessary to replace existing crops but also to the steady reduction being affected in the cost of plantation work.

May I now take the opportunity to thank all who have contributed to obtain these results and to say that I have reported to Government that all officers and subordinates of the Department have continued to co-operate most loyally to obtain the above results. Better value is probably being obtained than ever before for the reduced amounts that are available for expenditure and knowledge is being acquired and stored up for more prosperous time when the investment of further money in our forest estate should prove undoubtedly remunerative for the future. This leads us naturally to the object of our present Conference. Eventually we may look forward to having a short manual regarding *taungya* such as we have regarding working plans. But we consider that at this stage it would be premature to try and draw up such a manual.

The present Conference therefore aims at a general discussion of *taungya* in all its aspects, a general exchange of opinions and the pooling of experience that has been gained. From this an attempt will be made to determine, in a provisional way, what appear to be the possibilities of *taungya* and what should be the basis of our general policy in regard to it. Then next we wish to discuss the organization and administrative side of *taungya* and this leads on finally to the technique of the subject. Mr. Smythies has abstracted this division of the subject in the agenda before you. The results of the discussion will be summarized by him and the conclusions of the Conference will be recorded in the form of resolutions which will later be printed and distributed.

I would emphasize again that these conclusions can only be of a provisional nature at the present stage of development in *taungya* work, conditions vary from division to division. This Conference and the resolutions will, I hope, help those in divisions where the work is already in progress and stimulate others to investigate the possibilities

where *taungya* has not yet been started. I hope that in the future further conferences on the subject will be held and that we shall eventually be in a position to produce the short manual to which I have already referred.

I think it is essential that the officer who takes the chair at this Conference should be present throughout it and while I hope to be present to hear the proceedings for a considerable time I regret that I cannot spare from my other work all the time necessary for the complete sitting. I have therefore deputed Mr. Smythies to take control of the Conference and I now ask him to take the Chair."

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NULLIUS IN VERBA, OR EROSION IN THE HOSHIARPUR SIWALIKS.

BY H. M. GLOVER, I. F. S.

In the days of one's youth, when the unfortunate necessity for passing examinations caused one to read "Schlich, Vol. I," one gathered a rather hazy impression that all was not well with the forests and lands of the outer ranges of the Punjab Himalaya. The dates are significant; Schlich, Vol. I, was published in 1889 and the days of one's youth are past long ago.

Schlich's extremely moderate description of the Hoshiarpur Siwaliks will now be given: —

"The larger the proportion of the catchment areas, whence this irrigation water comes, which is shaded by forest vegetation, the more favourable and sustained will be the supply of water. Here then is a mission which forestry in India has to fulfil."

"The mechanical action of forest vegetation on sloping ground also is not without importance in India. There is sufficient evidence to show what careless or injudicious clearing of forests may do. Anyone who has ever stood on the hills behind Hoshiarpur in the Punjab, and looked down upon the plain stretched out towards the south-west, has carried away an impression which he is not likely to forget. In

Eroded slope of the north-eastern portion of the Katar Dhar.
Open to grazing, lopping and every abuse.
Vegetation has disappeared and as a result the soil is washed away in every rainstorm and spread over the fertile plains.
A *cho* is seen in the background.

that part the Siwalik range consists of an exceedingly friable rock, looking almost like sand baked together. Formerly, the range was covered with a growth of forest vegetation, but a number of years ago cattle owners settled in it, and under the combined attacks of man, cows, sheep, and goats, the natural growth disappeared, while the tread of the beasts tended to loosen the soil. The annual monsoon rains, though not heavy, soon commenced a process of erosion, and of carrying away the surface soil. Gradually small and then large ravines and torrents were formed, which have torn the hill range into the most fantastic shapes, while the *debris* has been carried into the plains, forming, commencing at the places where the torrents emerge into the plain, fan-shaped accumulations of sand, which reach for miles into the plain, and which have already covered and rendered sterile extensive areas of formerly fertile fields. Indeed, one of these currents or drifts of sand has actually carried away a portion of the town of Hoshiarpur. The evil has by no means reached its maximum extent, and if curative measures are not adopted at an early date the progress of transporting the hill range into the plain will go on, until the greater part of the fertile plain stretching away from its foot has been rendered sterile. To cure the evil, it is necessary to stop grazing, at any rate that of goats and sheep, so as to allow the hills to reclothe themselves with a covering of plants, shrubs, and trees, and to help by artificial sowing and planting wherever required."

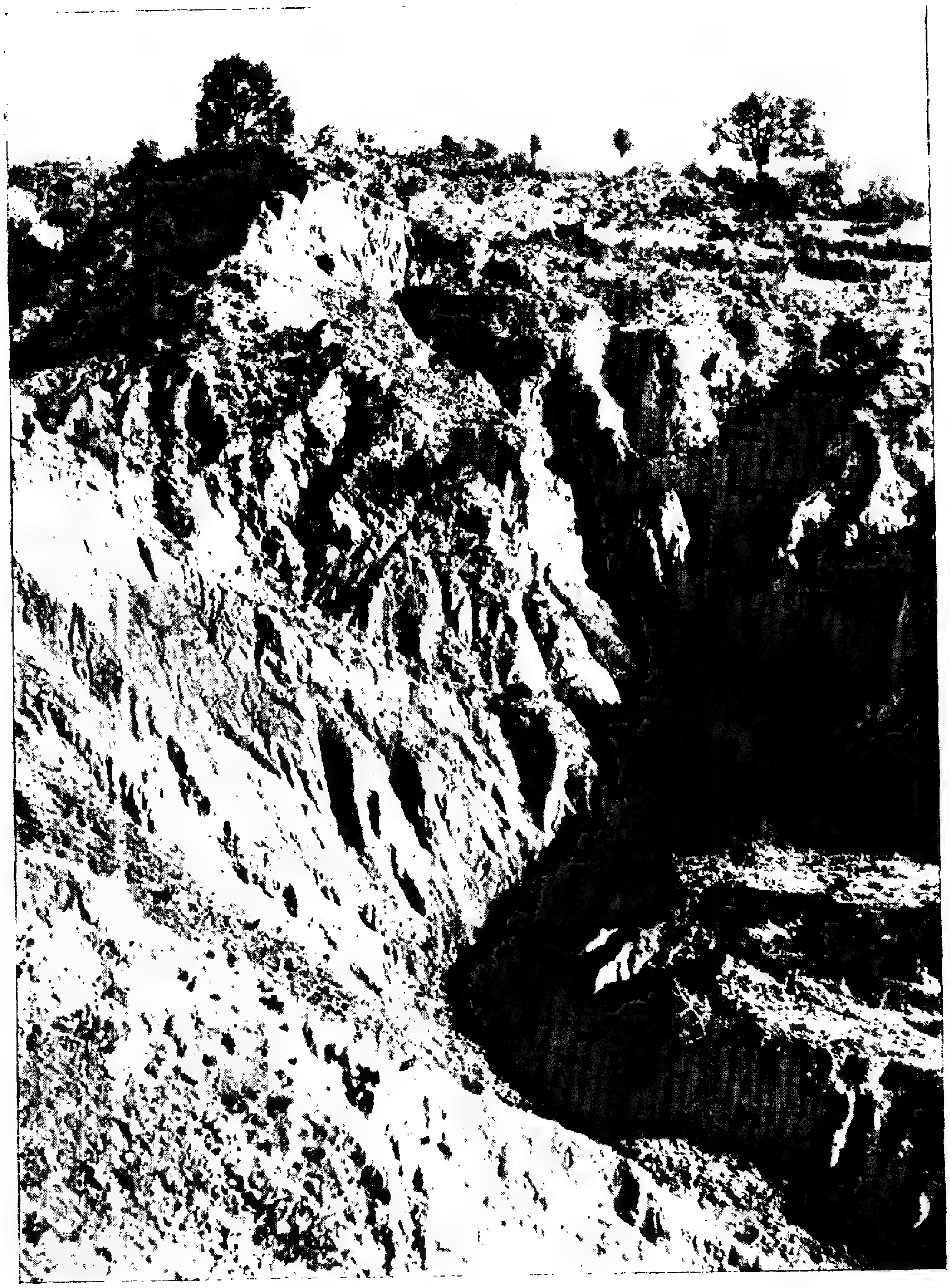
"Although the case of the Hoshiarpur *chos*, as they are called, is the worst of its kind in India, there are other instances which prove that afforestation is essential on hill-sides, wherever the rock is friable and liable to be carried away by the continued action of water. It would, however, be a mistake to assume that every hill slope requires to be under forest. Over considerable areas the rock is firm, and capable of holding its own without the steadying help of a growth of forest vegetation."

No apology is made for quoting the above, even though subsequently much has been written and much discussion has taken place as to what is to be done to check the ravages of the *chos*, or torrents of

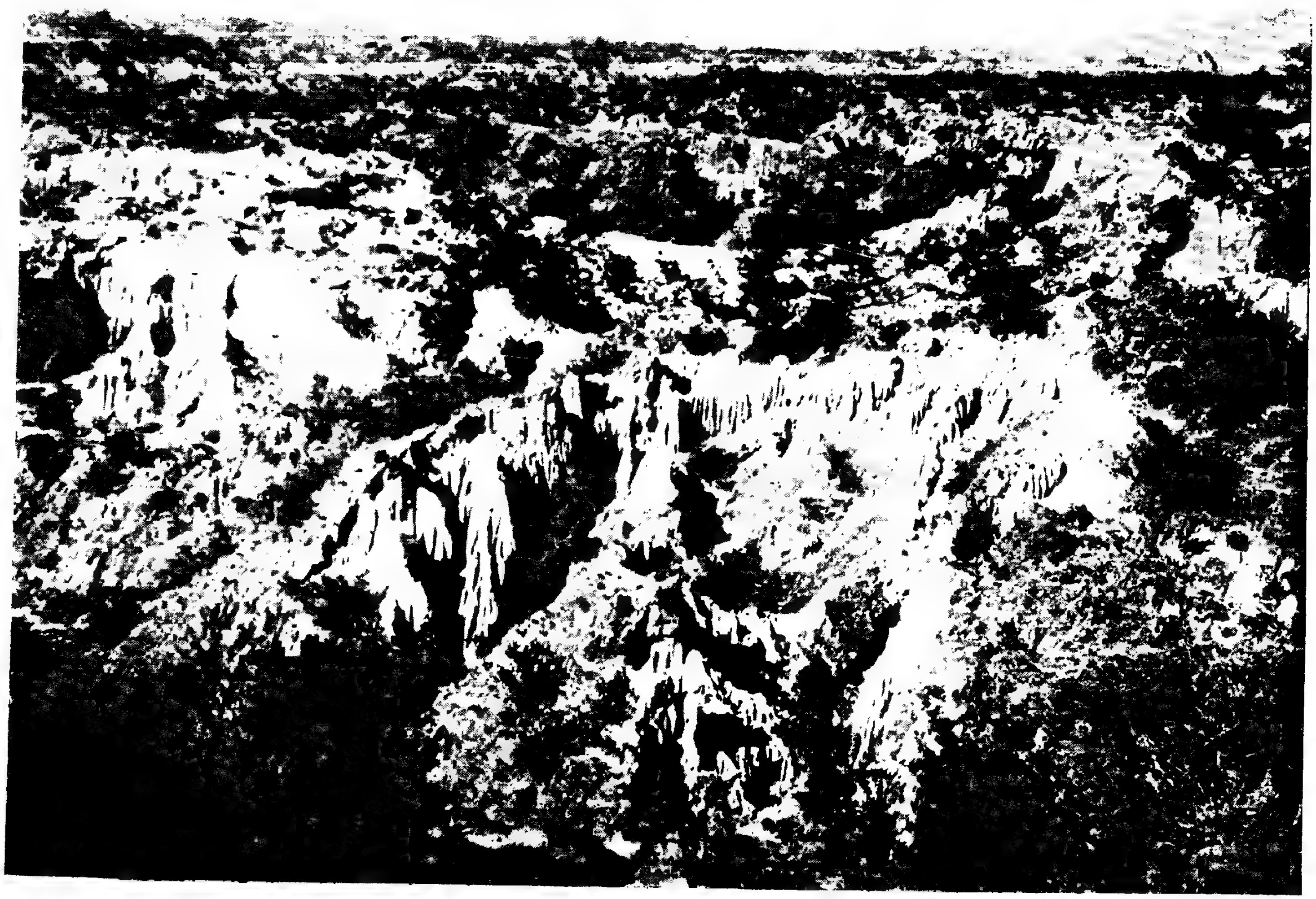
sand, which are spread over the valuable cultivation of the plains below. Much written: much discussed! The Punjab Council itself in this year of grace 1934, forty-five years after Schlich's volumes were first published, is now considering what effective steps can be taken to put a stop to the menace of erosion throughout the province. You now see the reason for the title of this paper *Nullius in Verba*, the motto of the Royal Society, which may be freely translated: *Don't Talk, Act.* No one who knows the character of the Punjabi would accuse him of dilatoriness once he is really convinced that action is required.

Let us examine what has been done. An act, called the *Chos* Act, 1900, was passed; an officer, Mr. L. B. Holland, then Assistant Conservator of Forests, was placed on special duty in 1913 but was recalled owing to the War in 1916, and the Deputy Commissioner, Hoshiarpur, protected the areas to which grazing closure had been applied. This Act gives Government full power to regulate grazing, wood-cutting and all abuses, and the act itself has been applied to the southern slopes of the Katar Dhar and there has been a great response of vegetation where protection has been adequately enforced. Where closure to grazing has been absolute, grass cutting after the summer monsoon has been permitted and villagers have thereby earned sufficient to pay the whole of their land revenue demand The cutting and sale of *bhabbar* grass have yielded a small return. A partial though by no means sufficient check has been put to erosion, but little has resulted from attempts at afforestation. The act has not been applied to the northern slopes where the forest has been subjected to every abuse and the country has been eroded to an extent which beggars description but is revealed in the accompanying photographs taken in February 1934.

Mr. Holland was again in 1928 placed on special duty to report on denudation and erosion in the low hills of the Punjab, and in 1932 a committee of the Punjab Legislative Council, with Mr. Holland as secretary, met to consider what action should be taken, and has since submitted its report confirming the accuracy of Mr. Holland's descriptions. The committee's recommendations, so far as they go, are a



Erosion on the north-eastern slopes of the Katar Dhar not brought under the *Chos* Act.



A part of the southern face of the Katar Dhar.
The application of section 4 of the *Chos* Act has been insufficient to prevent the destruction of the vegetation and the hills are still being eroded.

help, but they have been much watered down through fear of wounding the susceptibilities of local graziers. But having concluded that denudation is due to the destruction of vegetation by grazing and browsing, why not prevent absolutely grazing and browsing animals entering the areas from which thousands of tons of sand are scattered annually over immense areas of the plains ?

Numerous Gujars or professional graziers, mostly tenants, occupy villages at the lower edge of the forest and exist by trading in milk and *ghee* and appear to be increasing, and as families split up each unit brings its herds up to the numbers owned by the ancestral holding. The men who at present graze their cattle in the forest, Gujars, Rajputs and others alike, will have to take to stall-feeding their animals or to migrate elsewhere. Let the Forest Department be given the Katar Dhar to afforest without let, hindrance or incumbrance, and let its work be judged by results.

Again remembering our motto *Nullius in Verba*—Don't Talk, Act—let us consider in detail what must be done—

(1) The Katar Dhar down to the line of the plains must be closed absolutely to all browsing and grazing by goats, sheep, camels and buffaloes ; other horned cattle must be confined to small areas within 200 yards of the villages.

(2) The small hamlets and cultivation in the middle of the Katar Dhar must be expropriated as these form foci for grazing and consequent destruction of the vegetation.

(3) Grass cutting after the summer monsoon shall be permitted under supervision and encouragement shall be given to stall-feeding.

(4) Lopping of trees shall be absolutely prohibited. No green trees shall be felled until all danger of erosion is at an end, and then only under the strict control of the forest officer.

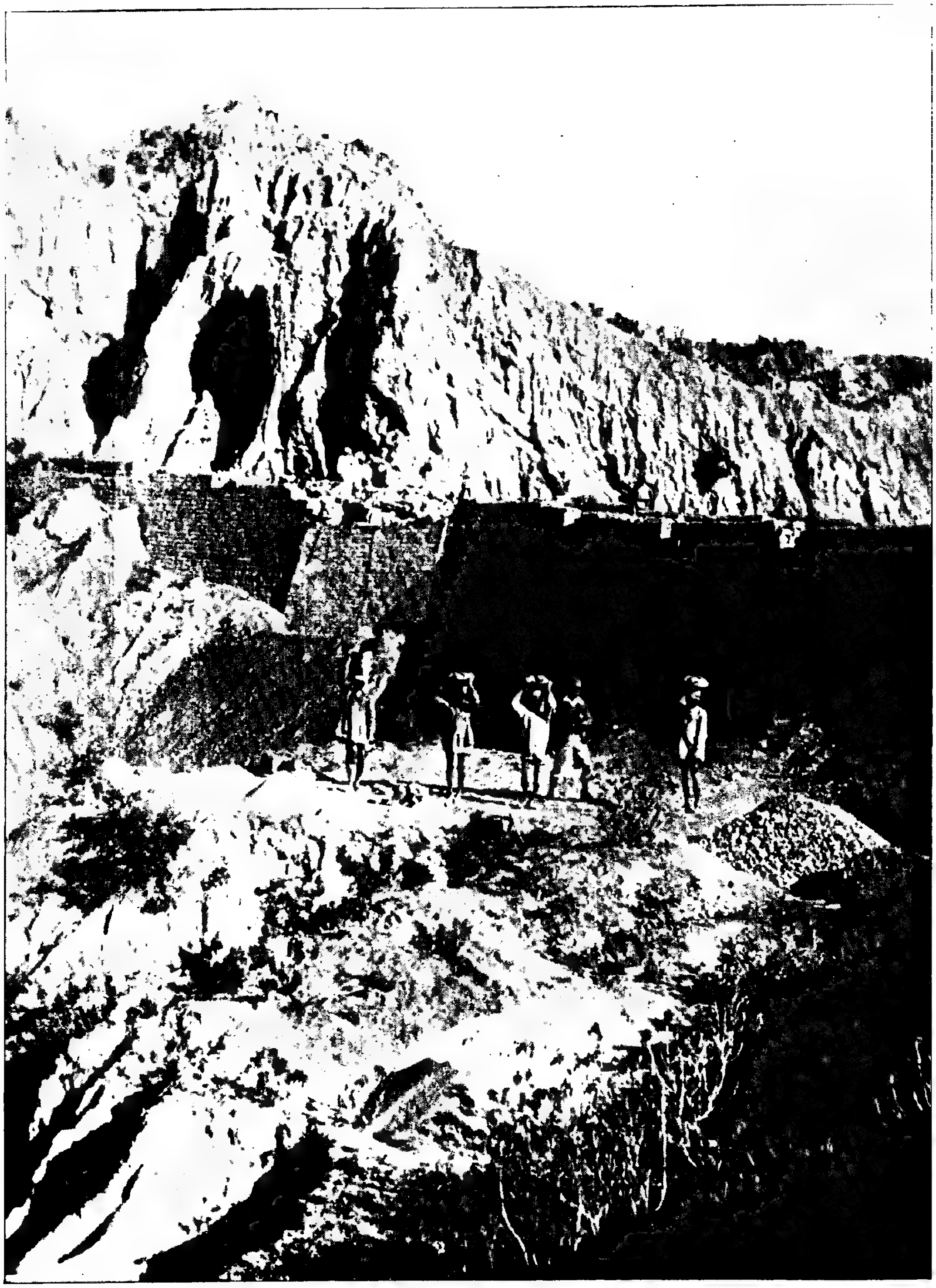
It may be thought that the above measures are repressive, but it is urged that the time for half measures is over and that as the stoppage of denudation and erosion is of paramount importance, no consideration should be paid to destructive practices and abuses

by the local population. As well attempt to harness an elephant with pack thread as to stop the avalanches of sand descending the hill-sides during the monsoon when grazing and browsing have destroyed the vegetation.

The rock is soft sandstone; the soil is a light sandy loam especially liable to erosion once the vegetative covering is removed. The heat during summer is intense and is only relieved in July by the breaking of the monsoon when heavy rain falls. During the autumn and winter very little rain falls and drying winds increase the desiccation of the soil. These conditions are favourable to growth during the monsoon alone and at other periods of the year vegetation only manages to persist with difficulty.

The natural vegetation consists of thorn forest with scrub trees of some 15 to 30 feet in height: *Acacia modesta* and its associates *Acacia catechu*, *Flacourtia*, *Zizyphus jujuba* and *nummularia*, *Ougeinia dalbergioides*, *Diospyros melanoxylon*, *Anogeissus latifolia*, *Dodonaea viscosa*, *Carissa spinarum*, *Adhatoda vasica*, and various grasses including the valuable *bhabbar* grass (*Ischoemum angustifolium*), form the climax type. *Chir* (*Pinus longifolia*) trees of low quality grow in open forests on the higher northern slopes. It will be seen that little revenue is likely to accrue from the sale of timber or firewood, and efforts should be concentrated on fixing the soil by species which make low demands on the factors of the locality with but little reference to their economic value. The hills bear a valuable crop of grass which should be cut under supervision as grass forms a valuable asset to the neighbourhood and is marketed in large quantities. An increase in the value of the forests as a hay reserve will occur when animals are excluded.

Some *bhabbar* grass grows and is a valuable harvest. This should be extended by dibbling and may be expected to flourish as the dry and barren nature of the slopes should prevent its extinction by other grasses. There is a vast demand for this product both for paper making and for ropes. Lac is extensively grown in the Hoshiarpur district and the *khair* and *ber* form excellent hosts. Both species occur



Roads through the Katar Dhar cost large sums to repair and their foundations are undermined every monsoon.

naturally in the Katar Dhar and should be extensively planted on the better soils. The increased value of the sales of grass and lac should go far to compensate local villagers for the exclusion of their animals. Bamboos should be grown on the sides of the nullahs and are likely to prove an economic asset.

On the eroding slopes it will only be possible to grow trees and bushes which make low demands on the factors of the locality. *Sanatha* (*Dodonaea viscosa*), *basuti* (*Adhatoda vasica*), *garna* (*Carissa spinarum*) should be sown or planted. The two former species though occasionally browsed are not liked by animals,—and the last is capable of growing on the poorest soil. Certain species have already proved of value in checking erosion and are already used by villagers for protecting their property, amongst which the following are of importance : *jubulota* (*Jatropha curcas*) and *tohr* (*Euphorbia royleana*) which are easily propagated by cuttings in February and during the monsoon ; *Vitex negundo*, which is of great value on the edges of nullah beds and able to withstand a rush of water ; *sarkana* grass (*Saccharum munja*), which is extensively planted on the edge of sandy *chos* in the plains. The northern slopes are so badly eroded that no scruples need be entertained as to the introduction of pests. It is far more important to check erosion by introducing species which are able to survive and spread and hold up the soil than to try to grow valuable species on ground to which they are unsuited. *Lantana*, agaves and opuntias should be grown on sterile slopes.

Fodder grass, *bhabbar* grass, lac, bamboos, resin and eventually firewood are all probable sources of revenue and it must be emphasised that proper management, which will enable local villagers to supplement their agricultural earnings by exploiting forest products, should more than compensate them for the exclusion of grazing animals from badly eroded areas of little value as pasture lands. Should the policy and action outlined above prove successful the Punjab will be able to tackle the wider problem of erosion throughout the whole of the lower slopes of the Outer Himalaya.

COLLECTION OF ROYALTY ON TEAK TIMBER IN BURMA.

BY "JAWTHA."

For the benefit of those not familiar with the method of collecting royalty on teak in Burma I give below a short résumé of the subject and would ask those already acquainted with it to skip the next 3 paragraphs.

When tenders are called for for the right to extract teak timber from any forest reserve or block of reserves or unclassed forests, tenderers are required to state the amount of royalty they are prepared to pay per ton of 50 cubic feet for the following classes of logs :—

(*a*) Full size logs, *i.e.*, logs measuring 30 cft. or over not classed as Refuse.

(*b*) Undersized logs, *i.e.*, logs measuring under 30 cft. and not classed as Refuse.

(*c*) Refuse, *i.e.*, all logs of any dimensions that are classed as Refuse by the Forest Department. It has lately been ruled that all logs cubing less than 20 cft. may automatically be treated as Refuse.

The firms interested invariably send a representative to inspect the area in advance and assess the value of the timber from such points as its quality, its accessibility, extraction routes, abundance or lack of fodder for elephants, etc. The point I wish to emphasize is that the quality of the timber is by no means neglected when determining the royalty rates.

In course of time the successful tenderer becomes the lessee and extracts to measuring stations not less than a specified minimum tonnage based on Working Plans or Girdling Schemes. These stations are places to which the logs can conveniently be extracted and offered for measurement. Measurement and classification are done by the measuring officer, a gazetted officer of the Forest Department, in the presence of the lessee. The lessee has the right to appeal against the classification of the measuring officer to the Divisional Forest Officer and the Conservator of Forests, *e.g.*, he may consider that a log over

30 cft. classed by the measuring officer as full size should have been classed as refuse and pay only the lowest rate of royalty.

To the casual observer this must appear to be an admirable system, and he will reason, rightly, that larger timber being more valuable than smaller timber should pay a higher rate of royalty than the latter and, *doubtfully*, that as even large logs may suffer from twisted grain, flutings, buttresses, knots, branch-holes, beeholes, wood-pecker holes, holes in the heart, sun cracks, splits, shakes, shatters and rot they may become so poor in quality that they cannot show a profit if they pay full-size rates but may be profitable at refuse rates. And then he pauses and considers what is a refuse log.

I must expand the last paragraph by shedding another illuminating ray on the word "*doubtfully*." Classification in the first place is based on quality and not value. If this first analysis made by the measuring officer results in his classifying a log as full-size the lessee must accept it as such or appeal to the Divisional Forest Officer and the Conservator of Forests; on the other hand should the measuring officer consider that the defects of the log have assumed such a scale that the lessee has a *bonâ-fide* claim for refuse the question of sale value crops up and three courses are open. (1) The lessee pays full size rates. (2) The lessee hands the log over to Government who on selling the log gives a percentage of the sale price to the lessee and keeps the rest. This percentage varies with the amount of the sale price, and Government's share may be greater or less than the royalty at refuse rates. (3) The log may be classed as refuse. It certainly will be so classed if it is obvious that a higher rate will not be obtained under the second method. The lessee can appeal against No. (1) and No. (2).

The modern Diogenes is a measuring officer looking for an honest border line refuse log. To my knowledge "refuse" has never been defined nor is its definition easy on a quality basis. Each of the defects mentioned in a previous paragraph are variables, and in addition their effect on the quality of a log varies with the dimensions of the

log. Also conservators of forests, divisional forest officers, measuring officers and lessees are human beings and a prey to the frailties of that species, in this case the personal factor.

I have discussed so far what should take place, but over several years measuring my experience has been as follows. My opposite number reads out the list of defects and looks at me hopefully, I praise the good qualities and look at him hopefully. He picks out each defect and eventually proves that there is no timber in the log at all. I discover a few "squares," "decks," "boards" or "scantlings." The log is turned once more and I say "full size." After it has been turned a few more times he may say it is badly bee-holed and from a notorious beehole forest. My reply is that he expected the timber to be bee-holed when he made his tender for the lease and hence it is no longer a deciding factor. He throws the log aside for appeal and we move on to the next. The tension is eased after we are in entire agreement on one log and so the day rolls slowly past. If the general quality is poor the better logs look magnificent and are classed as full size: if the general quality is good these full size logs become refuse because they look poor. After a few days of dog fighting I generally find that we reach a certain standard of mutual confidence and the classifying then speeds up. But where is the border line refuse log? Was it the amorphous log I had in mind when I commenced classifying or was it the log my opposite number had in mind or the average we strike after several days measuring?

The revenue of the Forest Department exceeds a crore of rupees and roughly 70 per cent. of it is obtained from the teak lessees. Well may the casual observer pause and consider what is a refuse log—the crux of the present measuring system and a stumbling block to every measuring officer! It places enormous responsibility on the measuring officers, many of whom are junior men. Equable classification requires prodigious concentration and a familiarity with the conversion of timber which no forest officer has the opportunity of acquiring. The difficulties of the present system are recognized and various suggestions have been made from time to time for their elimination

but as no solution has been arrived at yet, I will enumerate these suggestions and invite criticism from a wider circle through the pages of this invaluable "go-between," the *Indian Forester*.

Royalty measurement has proceeded on the present basis for many years now and the suggestion has been made that the average percentages should be taken of logs over 30 cft. passed as refuse to total logs over 30 cft. and similarly for logs under 30 cft. and these percentages accepted as the basis for classification. The present slow and expensive classification would be eliminated. The chief drawback to this method lies in the increased inspections which it would be necessary to make of the leavings in the forest to ensure that the lessees continue working to the old standards. A very serious drawback. A similar and more serious objection applies to the suggestion that lessees should pay a flat rate for all classes of timber. Inspection of the jungle work would have to be minute as there would be a greater temptation to leave behind logs which now form the poorer refuse quality.

Finally there is the ambitious and alluring suggestion that lessees pay a lump sum annually and take or leave what timber they wish. The forests of Burma have been under systematic management some 70 years but not under regular Working Plans all this period. Many areas are already in their second girdling circle and with few exceptions every forest has been worked over at some time so that the quality of the timber is known in every locality. It has become an axiom that the quality though not the size of the timber in the second rotation will excel that of the first under organised management. The grounds for this are that under organised management all defective, diseased and over mature trees are removed, all creepers cut, and only vigorous stock left behind. I use " organised management " advisedly in order to exclude those areas worked in the times of the Burmese Kings when only the finest timber was extracted.

The majority of the reserved forests are now under systematic working plans so that the yield in trees is known more or less accurately. A cubical contents yield table for each leased area can now be

made with fair accuracy from the returns made by the lessees. Working on these hypotheses cannot a money figure be arrived at which represents a fair return for an annual girdling of a fixed number of trees? It would be worth experimenting with this method in the Government extraction division.

The disadvantages of this method are at present many and depend to a large extent upon the inaccuracy of the yield tables and working plan statistics. It frequently happens that the yield in trees according to the working plan has to be altered as the girdling proceeds but a clause could be agreed upon whereby the original amount tendered would vary in proportion to the alteration in the number of trees. I do not suggest that the alteration should apply to the annual variations which are made to compensate each other. Another difficulty would originate in ascribing a money value to trees of different girths; but this is no more complicated than determining what royalty should be paid under the present system. It lacks the familiarity which is the present system's greatest attraction.

The advantages of the method are many and of such a magnitude that it is with difficulty that I restrain myself to refer to the salient ones only. The revenue of the Forest Department is assured, it does not depend upon fluctuating market prices, good or bad rainy seasons, outbreaks of disease in elephant camps and other "acts of God." The lessee pays for the timber as it stands in the forest; there is therefore no loss to Government arising from logs sinking, straying or being stolen before reaching measuring stations. The lessee is free from any restrictions regarding stump height, axe or saw felling, standard of marketability as it is understood by the inspecting forest officer, butting and other pin-pricks which make inspections lengthy, expensive and acrimonious. Inspections would still be required to ensure that unnecessary damage is not done to growing stock. Nor would there be this night-mare of the "border line refuse log" to make measuring officers lose faith in their fellow men and their own judgment.

MORE SWISS METEOROLOGICAL DATA.

Meteorological observations were taken at Oppligen comparing results in the open and under even aged and selection conifer crops. Previous efforts to collect such data in 1908 were not satisfactory, and the experiment was repeated during the summer months of 1927 and 1928. Three observation stations were set up, one in the open, one in an even aged spruce wood, and one in typical selection forest. Each was fitted with a maximum and minimum thermometer, a hygrometer, a wild evaporimeter, two Livingston atmometers and two cylinders for determining evaporation from the soil. Rainfall was measured only in the open. The data collected yielded the following results as summarised by Herr H. Burger in his article "Meteorologische Beobachtungen in Freien, in einem gleichaltrigen Fichten bestand, und im Tannen—Fichten—Plenterwald bei, Oppligen" on pages 153-191 of the Swiss Forest *Mitteilungen*, XVIII-I of 1933.

I.—Temperature.

(*i*). Comparison of average monthly temperatures in the open and under the even aged canopy showed the latter to be less by 0·6° to 2·1° C., the difference being greater in the height of summer than in spring or autumn.

(*ii*). Monthly averages were from 0·1° to 0·3° C., lower in the selection forest than in the evenaged one.

(*iii*). Monthly minima were 0·1° to 0·9° lower in the open than in the even aged stand, and 0·1° to 0·4° lower in even aged than in selection.

(*iv*). Monthly maxima were 1·9° to 5·0° higher in the open than in the even aged stand and 0·3° to 0·5° higher in evenaged than in selection.

(*v*). Monthly average variation was greater in the open, being 2·6° to 3·4° more than for the even aged wood and 3·2° to 4° more than for the selection wood.

II.—Humidity.

(*i*). The average monthly relative humidity was always from 12

per cent. to 21 per cent. more for forest than in the open for the months in question.

(*ii*). Comparing the two forests, monthly averages did not differ greatly, but individual readings at midday showed a markedly higher humidity for the selection type.

III.—Evaporation.

(*i*). Taking the average for the two seasons the evaporation in the even aged forest was 27 per cent. of that in the open and in the selection forest only 24 per cent. of that of the open. The evaporation in the selection type was 11 per cent. less than that in the even aged forest.

(*ii*). Figures for each month varied greatly, for instance in September 1927 evaporation in the selection type was only 11 per cent. of that in the open, while in July 1928 the figure was 33 per cent.

(*iii*). Evaporation is more nearly in inverse ratio to the humidity than in direct relation to the temperature. Atmometer readings are not absolute but give relative values for the climate of any given place.

(*iv*). The evaporation from the soil in the even aged forest was never greater than 27 per cent. of that of the open, and in the selection forest not more than 16 per cent. Soil evaporation in the selection forest was 40 per cent. less than in the even aged forest. The method of measurement by cylinders is however too dependent upon rainfall to give reliable results.

(*v*). Atmometer readings showed the air evaporation as being 8 grammes per hour or 35 grammes for 13 hours in the open, as against 1 gramme per hour or 9 grammes in 13 hours for the selection forest.

(*vi*). The principal factors affecting evaporation are insolation and air circulation. The duration of insolation has an indirect effect in modifying the temperature and the humidity of the air.

IV.—Conclusions.

From a graphical comparison of the results it appears that the causes of evaporation may be allocated 40—45 per cent. to the humidity

of the air, 15 per cent. to the difference in temperature, and 40—45 per cent. to the circulation of the air.

The differences between forest and open are clearly differentiated but the comparative value of the two forest types is of relatively small importance.

R. M. G.

DURABILITY TESTS ON UNTREATED INDIAN TIMBERS AT DEHRA DUN.

RESULTS OF LATEST INSPECTION—NOVEMBER 1933.

Serial No.	Species.	Period under test (in months).	Conditions.					Remarks (see footnote).
			Sound.	Slight attack.	Moderate attack.	Bad attack.	Destroyed or rejected.	
1	*Abies pindrow* ..	33	..	..	..	..	6	W.A.F.
2	*Abies webbiana* ..	15	..	..	..	..	6	W.A.F.
3	*Acacia arabica* (Sind) ..	37	..	..	2	4	..	
4	*Acacia arabica* (Sind) ..	34	..	1	1	1	2	W. A.F. only five specimens.
5	*Acacia catechu* ..	34	3	2	..	..	..	Ditto.
6	*Acer campbellei* ..	14	..	..	..	..	6	W. A.
7	*Acrocarpus fraxinifolius*	44	..	..	..	..	6	W. A. F.
8	*Adina cordifolia* (kiln seasoned) U. P. ..	49	..	..	..	..	6	W. A. F.
9	*Adina cordifolia*, U. P. ..	45	..	..	..	..	6	W. A. F.
10	*Adina cordifolia* (Bihar and Orissa) ..	39	..	..	..	..	6	F. W. A.
11	*Aegle marmelos* ..	29	..	..	..	..	6	F. W. A.
12	*Albizzia lebbek* ..	75	..	1	2	1	2	F.
13	*Albizzia lucida* ..	46	..	..	..	..	6	W. A. F.
14	*Albizzia odoratissima* ..	41	5	1	..	..	..	
15	*Albizzia procera* (Assam)	87	..	1	..	2	3	F. W. A.
16	*Albizzia procera* (Bihar and Orissa) ..	78	..	..	2	3	1	W. A. F.
17	*Albizzia stipulata* ..	44	..	..	..	..	6	F. W. A.
18	*Alstonia scholaris* ..	28	..	..	..	..	6	W. A. F.
19	*Altingia excelsa* ..	78	..	..	1	2	3	W. A F.
20	*Amoora wallichii* ..	47	..	5	1	..	..	
21	*Anisoptera glabra* ..	35	..	..	1	..	5	W. A.
22	*Anogeissus acuminata* ..	92	..	..	1	1	4	W. A. F.
23	*Anogeissus latifolia* ..	31	..	..	..	..	6	F. W. A.
24	*Anthocephalus cadamba* ..	23	..	..	..	..	6	W. A.
25	*Artocarpus chaplasha* ..	78	..	..	1	..	5	F.
26	*Artocarpus hirsuta* ..	71	..	1	..	..	5	F.
27	*Artocarpus integrifolia* ..	34	1	..	..	..	..	Only one specimen.

W. A.—Destroyed or rejected due to white ant attack.
F.—Destroyed or rejected due to fungus attack.
W. A. F.—Destroyed or rejected due to white ant and fungus attack.
F.W.A.—Destroyed or rejected due to fungus and white ant attack.

DURABILITY TESTS ON UNTREATED INDIAN TIMBERS—*continued.*

Results of latest inspection —November 1933—continued.

Serial No.	Species.	Period under test (in months).	CONDITION. Sound.	Slight attack.	Moderate attack.	Bad attack.	Destroyed or rejected.	Remarks (see footnote).
28	*Artocarpus integrifolia* (Madras) ..	5	4	..	..	..	..	Only four specimens.
29	*Artocarpus lakoocha* ..	34	..	3	..	..	..	Only three specimens.
30	*Bassia latifolia* ..	76	..	2	1	..	3	W. A. F.
31	*Berrya ammonilla* ..	55	..	1	4	..	1	W. A.
32	*Bischofia javanica* ..	55	..	..	..	..	6	W. A. F.
33	*Bombax insigne* ..	31	..	..	..	..	6	W. A. F.
34	*Bombax malabaricum* ..	12	..	..	..	..	6	W. A.
35	*Boswellia serrata* ..	44	..	..	..	..	6	F. W. A.
36	*Bursera serrata* (Burma) ..	67	..	..	..	..	6	F. W. A.
37	*Bursera serrata* (Bihar and Orissa) ..	76	..	..	1	4	1	W. A. F.
38	*Calophyllum elatum* ..	56	..	1	1	2	2	F. W. A.
39	*Calophyllum tomentosum*	71	..	..	..	3	3	W. A.
40	*Calophyllum wightianum*	75	..	..	..	1	5	W. A. F.
41	*Canarium euphyllum* ..	14	..	..	..	..	6	W. A.
42	*Canarium strictum* ..	36	..	..	..	..	6	F. W. A.
43	*Carapa moluccensis* ..	36	3	2	..	..	1	W. A.
44	*Careya arborea* ..	37	4	1	..	..	1	W. A.
45	*Castanopsis hystrix* ..	38	..	..	..	..	6	W. A. F.
46	*Castanopsis tribuloides* ..	69	..	2	4	..	..	
47	*Casuarina equisetifolia* ..	37	..	..	..	..	6	W. A. F.
48	*Cedrela serrata* ..	75	..	..	..	4	2	W. A. F.
49	*Cedrela toona* ..	50	..	..	..	..	6	F. W. A.
50	*Cedrus deodara* ..	75	..	1	3	2	..	
51	*Chickrassia tabularis* ..	52	..	..	1	2	3	F.
52	*Chloroxylon swietenia* ..	46	..	..	..	..	6	W. A. F.
53	*Cinnamomum cecicodaphne*	50	..	..	..	..	6	W. A. F.
54	*Cinnamomum iners* ..	27	..	..	..	5	1	W. A.
55	*Cinnamomum inunctum*	28	4	2	..	..	..	
56	*Cleistanthus collinus* ..	69	..	..	..	4	2	W. A. F.
57	*Crataeva religiosa* ..	9	..	..	..	..	6	W. A. F.
58	*Crypteronia paniculata* ..	46	..	..	..	..	6	W. A. F.
59	*Cryptocarya amygdalina* ..	23	..	..	..	..	6	W. A. F.
60	*Cryptomeria japonica* ..	12	..	..	..	..	6	W. A.
61	*Cullenia excelsa* ..	23	..	..	..	..	6	W. A. F.
62	*Cupressus torulosa* ..	24	6	..	..	..	..	
63	*Cynometra polyandra* ..	37	..	..	1	1	4	F. W. A.
64	*Dalbergia latifolia* ..	83	..	5	1	..	..	
65	*Dalbergia oliveri* ..	69	4	2	..	..	..	
66	*Dalbergia paniculata* ..	62	..	..	..	..	6	F. W. A.
67	*Dalbergia sissoo* (kiln seasoned) U. P. ..	86	..	..	..	2	4	W. A. F.
68	*Dalbergia sissoo* U. P. ..	83	..	4	2	..	..	
69	*Dichopsis elliptica* ..	75	1	..	..	..	5	F.
70	*Dillenia indica* ..	29	..	..	..	..	6	W. A. F.

(*See footnote on page* 337.)

DURABILITY TESTS ON UNTREATED INDIAN TIMBERS—*continued.*

Results of latest inspection—November 1933—continued.

Serial No.	Species.	Period under test (in months).	CONDITION. Sound.	Slight attack.	Moderate attack.	Bad attack.	Destroyed or rejected.	Remarks (see footnote).
71	*Dillenia pentagyna*	19	..	..	..	..	6	F. W. A.
72	*Diospyros melanoxylon*	49	..	..	..	..	6	W. A. F.
73	*Diospyros pyrrhocarpa*	37	..	..	..	..	6	W. A. F.
74	*Dipterocarpus alatus*	70	..	..	..	..	6	W. A. F.
75	*Dipterocarpus griffithii* (Burma)	27	..	..	..	..	6	W. A. F.
76	*Dipterocarpus griffithii* (Andamans)	45	..	..	..	2	4	W. A. F.
77	*Dipterocarpus indicus*	78	..	..	1	3	2	W. A.
78	*Dipterocarpus kerrii*	37	..	..	..	..	6	W. A. F.
79	*Dipterocarpus macrocarpus*	46	..	..	..	..	6	F. W. A.
80	*Dipterocarpus obtusifolius.*	45	..	..	..	..	6	W. A. F.
81	*Dipterocarpus tuberculatus*	67	..	..	..	..	6	W. A. F.
82	*Dipterocarpus turbinatus*	38	..	..	..	..	6	F. W. A.
83	*Dipterocarpus zeylanicus*	40	..	1	3	..	2	W. A.
84	*Duabanga sonneratioides*	50	..	..	..	..	6	W. A. F.
85	*Dysoxylum binectariferum*	69	..	4	2	..	..	
86	*Dysoxylum malabaricum*	62	..	6	..	..	..	
87	*Eriolaena candollei*	69	..	..	4	2	..	
88	*Eugenia gardneri*	50	..	..	..	..	6	F.
89	*Eugenia jambolana*	78	2	1	..	..	3	F.
90	*Eugenia karanensis*	92	..	..	..	2	4	F. W. A.
91	*Eugenia praecox*	40	..	..	..	..	6	F. W. A.
92	*Fraxinus excelsa*	21	..	..	..	..	6	W. A. F.
93	*Fraxinus floribunda*	29	..	..	..	..	6	W. A. F.
94	*Garuga pinnata*	13	..	..	..	..	6	W. A. F.
95	*Gluta tavoyana*	69	..	5	1	..	..	
96	*Gluta travancorica*	69	..	4	1	..	1	F.
97	*Gmelina arborea*	37	..	2	4	..	..	
98	*Grewia tiliaefolia*	78	..	..	..	1	5	W. A. F.
99	*Hardwickia binnata*	78	..	3	1	..	2	W. A. F.
100	*Heritiera minor*	56	..	..	..	..	6	F. W. A.
101	*Heterophragma adenophyllum*	70	6	..	..	..	..	
102	*Holoptelea integrifolia*	34	..	..	..	..	6	W. A. F.
103	*Homalium tomentosum*	64	..	..	..	..	6	W. A. F.
104	*Hopea cordifolia*	33	5	1	..	..	..	
105	*Hopea glabra*	39	2	..	1	2	1	W. A.
106	*Hopea odorata*	69	..	..	2	3	1	F.
107	*Hopea parviflora*	69	1	5	..	..	..	
108	*Hymenodictyon excelsum*	34	..	..	..	..	6	W. A. F.
109	*Juglans fallax*	25	..	..	..	..	6	W. A.
110	*Juglans regia*	31	..	..	..	..	6	W. A. F.
111	*Kayea assamica*	73	..	..	..	3	3	W. A. F.
112	*Lagerstroemia flos-reginae*	41	..	..	5	..	1	W. A.
113	*Lagerstroemia hypoluca*	69	..	5	1	..	..	
114	*Lagerstroemia lanceolata*	40	..	1	4	..	1	W. A.

(See footnote on page 337.)

DURABILITY TESTS ON UNTREATED INDIAN TIMBERS—*continued.*

Results of latest inspection—November 1933—continued.

Serial No.	Species.	Period under test (in months).	CONDITION. Sound.	Slight attack.	Moderate attack.	Bad attack.	Destroyed or rejected.	Remarks (see footnote).
115	*Lagerstroemia* spp. probably *lanceolata* ..	35	..	3	3	..	..	
116	*Lagerstroemia microcarpa* (kiln seasoned) ..	86	..	1	2	..	3	F. W. A.
117	*Lagerstroemia microcarpa* (West Coast) ..	86	..	..	1	4	1	W. A.
118	*Lagerstroemia parviflora*	58	..	..	..	..	6	F. W. A.
119	*Lagerstroemia tomentosa*	29	..	..	..	..	6	W. A. F.
120	*Lannea grandis* ..	12	..	..	..	..	6	W. A. F.
121	*Lophopetalum wightianum*	32	..	..	..	..	6	W. A. F.
122	*Machilus gamblei* ..	23	..	..	..	..	6	W. A. F.
123	*Machilus macrantha* ..	37	..	1	4	1	..	
124	*Machilus* spp. ..	42	..	..	..	..	6	W. A. F.
125	*Mallotus philippinensis* ..	4	6	..	..	..	..	
126	*Mangifera indica* ..	33	..	..	..	..	6	F. W. A.
127	*Melanorrhoea usitata* ..	69	1	4	1	..	..	
128	*Mesua ferrea* (Assam) ..	75	..	2	3	1	..	
129	*Mesua ferrea* (Madras) ..	69	..	4	..	..	2	W. A. F.
130	*Michelia cathcartii* ..	30	..	..	..	..	6	W. A. F.
131	*Michelia excelsa* ..	28	..	..	..	..	6	F.
132	*Michelia montana* ..	52	..	..	3	2	1	W. A.
133	*Miliusa velutina* ..	4	5	1	..	..	..	
134	*Mimusops elengi* ..	15	2	1	..	..	3	F. W. A.
135	*Mitragyna diversifolia* ..	38	..	..	..	..	6	W. A. F.
136	*Mitragyna parviflora* ..	51	..	..	..	..	6	F. W. A.
137	*Morus alba* ..	49	..	..	..	..	6	W. A.
138	*Morus serrata* ..	16	..	1	3	2	..	
139	*Myristica attenuata* ..	6	..	..	..	..	6	W. A. F.
140	*Ougeinia dalbergioides* ..	83	..	..	4	2	..	
141	*Parashorea stellata* ..	83	..	..	..	3	3	W. A. F.
142	*Parishia insignis* ..	21	..	..	..	..	6	W. A. F.
143	*Parrotia jacquemontiana*	14	..	..	..	..	6	W. A.
144	*Pentace burmanica* ..	69	..	1	4	1	..	
145	*Pentacme suavis* ..	66	1	1	4	..	..	
146	*Phoebe hainesiana* ..	69	..	..	1	4	1	W. A. F.
147	*Picea morinda* ..	40	..	..	..	..	6	W. A. F.
148	*Pinus excelsa* ..	74	..	..	..	1	5	W. A.
149	*Pinus longifolia* ..	44	..	..	..	..	6	W. A. F.
150	*Planchonia andamanica* ..	23	..	..	..	..	6	W. A. F.
151	*Podocarpus neriifolia* ..	37	1	1	2	1	1	W. A.
152	*Podocarpus wallichianus* ..	6	1	2	2	..	1	W. A. F.
153	*Poeciloneuron indicum* ..	76	..	..	..	2	4	W. A. F.
154	*Polyalthia fragrans* ..	27	..	..	..	..	6	W. A. F.
155	*Pterocarpus dalbergioides*	84	..	6	..	..	..	
156	*Pterocarpus marsupium* ..	71	..	3	1	2	..	
157	*Pterospermum acerifolium*	28	..	..	..	..	6	W. A. F.
158	*Quercus lamellosa* ..	29	..	..	..	..	6	F. W. A.

(See footnote on page 337.)

DURABILITY TESTS ON UNTREATED INDIAN TIMBERS—*concluded.*

Results of latest inspection—November 1933—concluded.

Serial No.	Species.	Period under test (in months).	Condition. Sound.	Slight attack.	Moderate attack.	Bad attack.	Destroyed or rejected.	Remarks (see footnote).
159	*Quercus lineata* ..	54	..	3	..	..	3	F. W. A.
160	*Schima wallichii* ..	59	..	..	..	1	5	F. W. A.
161	*Schleichera trijuga* ..	76	..	..	1	..	5	F. W. A.
162	*Shorea assamica* ..	60	..	..	..	..	6	W. A. F.
163	*Shorea obtusa* ..	66	4	2	..	..	..	
164	*Shorea robusta* ..	74	2	3	1	..	..	
165	*Shorea talura* ..	62	..	..	..	..	6	W. A. F.
166	*Sonneratia apetala* ..	20	..	..	..	..	6	W. A. F.
167	*Soymida febrifuga* ..	69	4	2	..	..	..	
168	*Sterculia campanulata* ..	10	..	..	..	..	6	W. A. F.
169	*Stereospermum chelonoides*	23	..	..	..	..	6	W. A. F.
170	*Stereospermum suaveolens*	25	..	..	..	..	6	F. W. A.
171	*Stereospermum xyliocarpum* ..	3	6	..	..	..	..	
172	*Swintonia floribunda* ..	18	..	..	..	..	6	W. A. F.
173	*Tectona grandis* ..	74	..	..	3	2	1	F.
174	*Terminalia arjuna* (C.P.)	33	..	1	1	4	..	
175	*Terminalia arjuna* (Madras) ..	27	..	1	2	..	3	W. A. F.
176	*Terminalia arjuna* (sapwood) (Madras) ..	27	1	1	1	..	1	W. A. F.
177	*Terminalia arjuna* (mixed sap and heart wood) (Madras) ..	27	..	3	..	..	1	W. A. F.
178	*Terminalia arjuna* (heartwood) (Madras) ..	27	3	1	..	..	..	
179	*Terminalia belerica* ..	51	..	..	..	..	6	W. A. F.
180	*Terminalia bialata* ..	55	..	..	..	..	6	W. A. F.
181	*Terminalia chebula* (Burma) ..	67	..	..	..	..	6	W. A. F.
182	*Terminalia chebula* (Assam)	14	..	..	..	..	6	W. A. F.
183	*Terminalia manii* (kiln seasoned) (Andamans) ..	61	..	..	..	..	6	W. A. F.
184	*Terminailia manii* (Andamans) ..	45	..	1	..	4	1	W. A.
185	*Terminalia myriocarpa* (white hollock) ..	37	..	..	..	..	6	W. A.
186	*Terminalia myriocarpa* (black hollock) ..	37	5	..	..	..	1	F.
187	*Terminalia oliveri* ..	87	..	..	..	1	5	W. A. F.
188	*Terminalia paniculata* ..	61	..	..	..	..	6	W. A.
189	*Terminalia procera* ..	45	..	..	..	..	6	W. A. F.
190	*Terminalia pyrifolia* ..	31	..	..	..	..	6	W. A. F.
191	*Terminalia tomentosa* ..	92	..	..	1	1	4	F. W. A.
192	*Ulmus wallichiana* ..	11	..	..	..	..	6	F. W. A.
193	*Vateria indica* ..	28	..	..	..	..	6	W. A.
194	*Vitex altissima* ..	28	3	3	..	..	..	
195	*Xylia dolabriformis* ..	75	..	1	1	..	4	F. W. A.
196	*Xylia xylocarpa* ..	41	3	3	..	..	..	

(See footnote on page 337.)

DESTRUCTION OF PRICKLY PEAR IN MEWAR STATES (RAJPUTANA)

BY BHAI CHARAN DASS, FOREST RANGER, MANDLA, C.P.

The prickly pear (*Opuntia dillenii*) was brought into India over a century ago from South America as a hedge plant. It has grown and spread in some parts of the country with great rapidity chiefly due to the fact that pieces of stem and branches take root readily even if stuck in or merely thrown on very poor and hard soil and without resort to watering. The flat succulent branches are covered with long sharp spines and are therefore not touched by cattle. The cuttings put in at any time except the rains begin to grow and within one year make an impenetrable hedge. The prickly pear is also used in Mewar as a fodder for feeding cattle, after scorching off its spines, during the years when there is great scarcity of fodder, and the cattle take to it when they can get nothing else to eat.

The cactus hedge if not regularly trimmed gets out of control and is soon apt to become a troublesome weed. In Mewar its rate of growth is very quick and it is even found growing on walls. It is gradually covering grazing grounds and shikar reserves and in certain well-known shikar beats, namely, Ikoljia and Hinglojia, it has grown so thick that beaters cannot pass through. The cultivators too have become quite disgusted with this cactus as it is firstly, covering most of the land, and, secondly, it affords safe harbourage close to their fields for wild pig whose depredations cause enormous loss to them. The shooting of pigs is strictly prohibited in the state as pig shooting and sticking is a favourite game of the Rajputs especially in Rajputana, and pork (*santhh*) is their most valued dish.

As the disadvantages of cactus far outweigh its advantages, therefore, efforts were made to check the growth of this pest by burning it when it got dry, but this soon proved futile, being not only very expensive but ineffective. I was told by Colonel Field, the Resident for Mewar, that there is a wild bug which is said to feed only upon cactus. In July 1932 I referred the matter to the Forest Entomologist, Dehra Dun, and sought his advice. He suggested that the

insect now being used in India for the destruction of the cactus (*Opuntia dillenii*) is a wild cochineal *Dactylopius tomentosa* and it could probably be obtained from the Government Entomologist, Mysore, or from the Divisional Forest Officer, North Salem, Madras. I accordingly wrote to the latter who was kind enough to send by train parcel two baskets full of cactus infected with cochineal, which reached me on 8th August 1932. I was out in camp and had unfortunately failed to leave any instructions at the office. The Station Master, however, seeing that the contents were going bad, sent the baskets to my office. They had been tampered with *en-route* but the very sight of cactus instead of fruits must have caused great disappointment to the thieves ! The head clerk seeing cactus so common in Mewar thought that some one was simply befooling me so he took no heed of the poor cochineal ! On my return on the 13th August 1932 I immediately released the cochineal by putting the infected cactus sent to me on young and tender cactus growing just outside the compound wall of my bungalow. The insects were so small that I could not believe that they could ever destroy cactus growing over an extensive area. Anyhow I went practically daily to see the insects which after 17 days were noticed to move and grow white threads looking like tiny balls of cotton. The insects multiplied with great rapidity. The destruction of cactus, *viz.*, dropping of pieces of cactus from the nodes, was apparent in December but from February to July it was so quick and thorough that the place was daily visited by several people to satisfy their curiosity. Within a year they have completely cleared of cactus an area of about 2 acres. There are now hundreds of cart loads of cactus thoroughly infected with cochineal ready for release. In fact it has been sent to several other places where cactus abounds and the Revenue Commissioner, Mr. Trench (I.C.S., retired), takes a great interest in this work and explains to his cultivators how to put infected cactus on that growing round about their holdings. If nothing unforeseen happens it can safely be said that cactus will disappear from Mewar within 10 years without incurring any expenditure. On the other hand eradication by burning would have cost at least half a lakh of rupees.

The following note on cochineal was supplied by the Research Ranger, Dankanikota (Madras) and is reproduced in the belief that it may be found of general interest:—

"The cochineal is a kind of scale insect belonging to the group of bugs and like all bugs feeds by sucking. The female when full grown is dark red in colour and about the size of a horsegram. It has three pairs of legs and a slender proboscis with which it pierces the skin of cactus and sucks nourishment. The young is like the adult, oval in shape but flatter. Soon after it settles down on a cactus branch, it begins to grow white threads from all over the upper side of the body and these grow so thick and long that the full grown one looks like a tiny ball of cotton, but when this fluff is removed with a pin or thorn the red insect underneath may be seen. The male is different from the female in that it has a pair of wings and two long white threads at the hind end. It has also two feelers and three pairs of legs. The wings are provided to enable it to fly to the female and pair with her. Though so different from the female, it looks when young just like the young of the female but later on it becomes longish and the wings grow from the sides. In the meanwhile it also will have made a small cocoon in shape like the cocoons of the silk-worm and clusters of these may be found in certain seasons on branches of cactus. The male unlike the female does not feed in the adult stage. Sometimes there are too many of them and the females are too few. Little harm is then done to cactus. When there are enormous numbers of males produced, they may be seen flying or carried away by the wind from the bushes. Each female may produce 200 to 500 young and the life of a female is about 2 months. In a year there may be as many as six generations so that one female may produce in the course of one year 2,000,000,000, insects. The precautions to be observed may now be described.

First, in regard to getting the supply, it is necessary to go at a time when the insects are fully ripe, that is to say when they are about to bring forth young. The insect with its cottony covering would be then about the size of a pigeon pea. If they are taken too early they will die off. The full-grown insects rarely travel from the

point where they have fixed themselves. They will not move even if the branch on which they are is cut. They will just die there, not of course soon after removal, but after a few days. It is the young from the ripe mothers that transfer themselves to other bushes. They wander for some time to select a suitable place and being young they prefer tender shoots of cactus which they can pierce more easily with their beaks. *In infecting bushes it is best if small cactus pieces about an inch square are pinned on to thorns near tender branches and the bush selected is under shade.* It is not necessary to attach several branches to one bush. The second point to observe is that, as already stated, males are sometimes produced almost exclusively and no females. There is little use in taking cactus branches containing such for infection purposes. If the insects are left to themselves, the spread is only about 2 furlongs in 2 years. If, on the other hand, they are spread by hand, they will spread very much more widely. The insects should therefore be spread about every two months, for the young ones take about that time to reach the adult stage and reproduce. The spreading should coincide with each successive generation. A man should be sent out then to select proper branches, cut them into pieces and pin them on to bushes which show no insects. In this way the insect will spread very rapidly and cactus may be killed off to a very large extent in a few years. Except for the labour of spreading, no cost is incurred."

[The insect attacks only *Opuntia dillenii* and *nigricans* and no other. There is no fear that they will become a pest on other plants. This has already been made clear in Dr. Beeson's account of the Cochineal Insect on pages 203-05 of the *Indian Forester* of March 1934.—*Ed.*]

CREOSOTED SLEEPERS.

By H. M. Glover, I.F.S.

In these days of economy it is pleasing to see the progress made by the North Western Railway in creosoting sleepers at Dhilwan. The wooden sleeper has to compete with serious rivals in cast iron and steel and must be produced at low cost and be capable of lasting

in the track for a period comparable with that of the metal sleeper. The competition which the wooden sleeper has to face is revealed by the following figures. In 1928 there were in the North Western Railway lines 12,923,000 wooden sleepers and 4,582,000 metal sleepers. In five years the increase in the numbers of wooden sleepers was 65,000 and in metal sleepers 809,000. For the whole of India the figures were in 1928, wooden sleepers 50,820,000 ; metal sleepers 36,470,000 ; in 1932, wooden sleepers 51,784,000 ; metal sleepers 44,288,000. Thus we see that whereas wooden sleepers increased by 964,000, metal sleepers increased by 7,818,000.

The deodar sleeper is expensive and is not proving as satisfactory as formerly, owing partly to the increased axle loads and the greater speed of the trains, and partly to the stricter specification demanded by the railway authorities. Untreated deodar sleepers laid in 1904 gave an average life of 20 years ; those laid in 1905 to 1909 gave a life of 17 years ; those laid from 1918 to 1921 gave a life of only 11 years.

As an experiment deodar sleepers were creosoted in 1926 and laid in the main line near Beas next to untreated sleepers of the same species laid in the same month and year. There is no comparison between the appearance of the untreated and treated sleepers : the former show every sign of requiring early removal owing to cracks and splits and are in marked contrast to the treated sleepers which obviously have suffered little from the heavy and fast traffic.

Chir, *kail* and fir after treatment in a creosoting plant are proving to be cheaper and successful substitutes for deodar and are able to compete with the metal sleeper.

The Chief Engineer is of opinion that the crude oil, mixed with the creosote originally to cheapen treatment, is the cause of the prevention of cracks and splits, it acts as a preservative and is largely a reason for the very satisfactory results.

The plant and process have already been described in detail in a previous issue of the *Indian Forester* and a few facts and figures of the sleepers treated and their behaviour in the line may be of interest. The preservative used, after testing at Dehra Dun and under the

advice of the Forest Research Institute, consists of a mixture of 40 per cent. creosote and 60 per cent. crude oil and is forced into the sleepers under a pressure of 175 to 180 lbs. per square inch and a temperature of 175 to 180 degrees Fahrenheit, by a modification of the Rueping process, with an absorption of some 15 or 16 lbs. per sleeper.

Chir has proved an eminently suitable timber for treatment. Checking and splitting are prevented and the sleepers are giving excellent service. Some of the *chir* sleepers treated in the old open tanks, before Dhilwan methods had reached their present pitch of perfection, have already lasted for 17 years in the line. It is certain that the average life of the *chir* treated sleeper will not be less than 15 years and may perhaps extend to 20 years, lives which are considered satisfactory by the railway authorities. The following figures speak for themselves :—Between 1915 and 1918, 237,300 *chir* sleepers supplied by the U.P. Forest Department were treated by the open tank process: of these 119,000 are still in the track. Similarly 250,000 were treated between 1921 and 1923 and of these 128,500 are still in service. In 1924, 182,000 *chir* sleepers treated under pressure were laid in the track, and only 33 per cent. were bored for taking the spikes before treatment. 5,000 were removed for reasons other than failure of the sleepers and of the balance practically all are still in the track making the life to date of 10 years which is a very satisfactory result.

Kail and fir sleepers are now all incised and bored before treatment in the pressure cylinder as these timbers resist impregnation. *Kail* is comparatively costly and is mechanically not so strong as other conifers : fir, in which term silver fir and spruce are included, is cheap and available in large quantities but absorbs creosote only superficially, but when incised before treatment side penetration is much more satisfactory. It was thought a short time ago that the absorption of creosote by the fir sleeper was insufficient to ensure a long life in the line, but an examination of the figures of sleepers laid down ten years ago shows that actually in practice the railways are getting good value, particularly when we remember that ten years

ago creosoting was in its infancy in India. 322,500 fir sleepers were treated by the open tank process between 1920 and 1923, but were neither bored nor incised before treatment, and it is surprising to find that 156,000 are still in service, particularly as it is known that many of these sleepers were of very low grade and of doubtful soundness. In 1924 84,600 fir sleepers, pressure treated but not incised and only 33 per cent. bored before treatment, were laid in the track; 3,400 were removed for reasons other than failure of the sleepers and of the balance of 81,200, 73,500 are still in use after ten years. With pre-boring and incision before treatment and with the improved technique now practised much better results are anticipated.

The cost of treatment amounts to the following per sleeper :—

		Rs. a. p.		Rs. a. p.
Chir	..	1 10 6	or less carriage from supplying depot to Dhilwan.	1 1 5
Fir	..	1 4 10	....	1 1 8
Kail	..	1 4 2	....	1 0 8
Deodar	..	1 2 1	....	0 15 1

The actuals vary according to the numbers of sleepers treated. The items are as numerous as those of the khansama's daily account and need not be given in detail, sufficient to say that every conceivable charge, inclusive of overhead, has been debited.

The extent to which treated sleepers have been used by the North Western Railway is not generally known and the following figures are of great interest :—From 1923 to 1933, 2,005,773 fir sleepers, 2,246,509 *chir* sleepers, 179,398 *kail* sleepers and 23,775 sleepers of other species have been treated making a total of no less than 4,455,455, or four and a half million sleepers. Creosoting is no longer in its infancy and the North Western Railway is to be congratulated on the magnitude and success of its effort.

In this successful experiment the Imperial Forest Research Institute can claim its share as throughout the period the North Western Railway has consulted the Forest Research Institute and has acted on its advice.

STILL SIMPLER CONTROL FORMS.

By E. A. Smythies, B.A., I.F.S.

1. Mr. Wright in the *Indian Forester* of April 1934 makes a plea for simpler control forms and refers in his article to that dreadful relic of a bygone age, the old code form 2, which as he points out was little more than another set of accounts, and, as experience proved, about as useful for real control as a picture postcard. He also refers to sample control forms published on pages 186--189 of *Practical Forest Management*, which also have long been extinct in the U. P. He gives examples of simplified control forms A and B, in which all information not essential for control purposes is eliminated, but at the same time " the whole felling history of each and every compartment is given," with volume of growing stock per acre, etc. I venture to suggest that the two statements quoted above are *mutually contradictory*, and it is scarcely possible to give a compartment history in a control form without including information not required for the annual control. Thus in form A (for volume yields) we find a great mass of figures, which presumably also occur in compartment histories, and *most of which are not required at all to control* the simple working plan prescription that 450,000 cft. p.a. should be felled from anywhere in P. B. I. Again in this form there are 61 entries which are merely repetitions of entries in a previous column, involving an amount of extra clerical labour which it would be useful to avoid.

In form B (for area yields), the working plan prescribes specific compartments to be thinned in specific years. Surely it is scarcely necessary to provide 10 columns for each compartment of which 9 will of necessity remain blank. The control of such a prescription can be done in a very much smaller and more convenient form. Further the working plan gives no prescriptions about *volumes* to be removed, and the 10 columns provided for volume felled also appear unnecessary to control the working plan prescriptions.

2. At the end of this article, the information given in Mr. Wright's sample forms A and B is shown for comparison as it would

be recorded in the corresponding standard control forms used in the U. P. It will be noted in form 29—comparable to form A—that the mass of figures is reduced to the minimum *necessary for control*, (but no figures necessary for control of working plan prescription are omitted), and everything in the nature of history is regulated to its proper place—the compartment history register. In 1932-33 the D. F. O. enters 33 figures in form A, compared to 3 in form 29. It will also be noted that there are not 61 —or in fact any—repetitions of figures previously recorded. In form 29B—comparable to form B—it will be noted that 90% of the available space is not wasted or left blank, there is no unnecessary repetition of the area of compartments, and any areas left undone are made conspicuous by a blank opposite them in the 5th column, which persists until they are done, a much more convenient way of spotting arrears than the plus and minus ledger account given at the bottom of form B. But more important still, deviations from the working plan prescriptions in the U. P. forms are almost automatically obvious (and they are always entered or underlined in red), and a reference to the order of the authority sanctioning the deviation has always to be quoted in the final or remarks column. (If not quoted, it shows that the proper sanction for the deviation has not yet been obtained). Mr. Wright's forms give no indication at all whether deviations have been sanctioned or not, and this we consider to be the first essential for a suitable control form.

3. A very considerable amount of time and thought has been spent on control forms and on control procedure in the U. P., and the Inspector-General of Forests has asked me to write up a brief description of our control forms and procedure for public information, so that this very important matter may be discussed in the pages of the *Indian Forester*.

4. To consider first the evolution of the control forms themselves. Every D. F. O. and Conservator in the province was sick to death of the enormous and unwieldy code forms *kept up in manuscript* (as no typewriter could type them), and we started off with the

following basic ideas :—

(*i*) That *all* control forms should be reduced to foolscap size, so that they could be typed in duplicate or triplicate. (The D. F. O. has his own copy and Conservator has his.)

(*ii*) That only information required for control of working plan prescriptions should be entered in control forms, all other information to be shown in compartment histories.

(*iii*) That the work of the D. F. O. in making annual entries should be as simple as possible and be reduced to a minimum.

(*iv*) That all working plan prescriptions for fellings, cultural operations and plantations should find a place in control forms, and that there should be separate forms for—

Fellings (*a*) volume yield (form 29)

(*b*) area yield (form 29B)

Cultural operations (form 29C)

Plantations (form 29E).

(*v*) That all deviations should be automatically obvious—the great failing of earlier control forms. This problem required very careful thought, but the control forms, as ultimately evolved, have satisfactorily solved it.

(*vi*) That the control forms should automatically show whether deviations had received the sanction of proper authority. A very useful form resulted called the Deviation Statement (29G), which gives at a glance and on one page all the deviations of a year from the prescriptions of all working circles of a working plan, and also shows whether the deviations have already been sanctioned or still require sanction.

5. Starting with these basic ideas, various standard control forms were evolved, and samples of the more important ones are given at the end of this article. These require a few explanatory remarks.

Form 29A. This is a supplement to form 29, and gives the necessary data to check column 2 of form 29. It also shows the

compartments and areas actually felled, which information is frequently required for the cultural operations form 29C.

Form 29B. Control for *area* yield. The headings and all entries for the whole working plan period are made in columns 1—4 by the Working Plans Circle before issue to D. F. O. at the commencement of a plan. The D. F. O.'s annual work consists in quoting the correct year in column 5, and giving sanction reference (for deviations) or explanatory remarks in column 6.

Form 29C. Control for cultural operations, climber cutting, departmental thinnings, etc. Where such operations are prescribed for definite areas in definite years the headings and first 4 columns are filled up for the whole working plan period by the Working Plan Officer. Where, however, they are prescribed to follow the fellings, these 4 columns are filled up yearly when the areas actually felled over are known. Here again the entries in columns 5 and 6 are very simple for the D. F. O.

In these 3 important forms, it will be seen the clerical work in the divisional office has been reduced to a minimum. If there are no deviations, the total clerical work amounts to entering 3 sets of figures in form 29, and *just one date* in each of 29B and 29C.

These control forms have now been in use for 6 or 7 years, and have stood the test of time. Every forest officer in the province is unanimous about their merits and simplicity, their handiness and saving of labour, and I can vouch personally for their far greater efficiency in the work for which they are designed, namely control of the working plan prescriptions.

6. To turn now to the procedure concerning control forms. I have already indicated that their initial preparation is done by the Working Plan Officer himself, who should know better than anyone else what his working plan prescriptions are. But the whole success of these simplified forms depends on the accuracy and care with which they are initially prepared, and so the responsibility for their correct initial preparation rests with the Conservator of Forests, Working Plans Circle. When a new plan has been sanctioned by the Chief

Conservator of Forests, the control forms are typed in duplicate, and bound in loose leaf clip files.

The D. F. O. types his annual entries in both copies (all deviations being underlined with red ink), and sends the flying copy through the territorial Conservator (who has no responsibility or trouble over control forms) to the Conservator of Forests, Working Plans Circle, for checking. Discrepancies (if any) having been explained, the latter forwards only the Deviation Statement (Form 29G) to the Chief Conservator of Forests with his comments on the deviations, who thus sees the control of working plan prescriptions very summarised and peptonised, and he sanctions such deviations as he has not already sanctioned, with his comments or orders for the future.

A very important principle is involved in deviations. The Chief Conservator of Forests is the authority who sanctions all working plans, and must therefore be the authority to sanction all deviations from working plan prescriptions. By the time control forms are prepared, deviations are already *faits accomplis,* and the Chief Conservator of Forests has no option but to sanction them. There is, therefore, standing order that all deviations that can be foreseen and especially all important deviations of excess or advance fellings, *must receive the Chief Conservator of Forests' previous sanction.* This involves a good deal of prior correspondence between the territorial Conservator, through the Conservator of Forests, Working Plans Circle, to the Chief Conservator of Forests, and in actual practice we do not bother about prior sanction for minor deviations, and particularly deficit fellings due to unsaleable lots, which are usually sanctioned on the deviation statement. Some prior correspondence is however inevitable to give C. C. F. the necessary adequate control over important deviations. All such correspondence (and all proposals for modifying sanctioned working plans) passes through the Conservator of Forests, Working Plans Circle, who records his own views, and discusses such proposals from the working plan point of view.

The standard control forms and the procedure described above ensure a far more efficient control than was previously the case. I

have limited this note to a description of the control over fellings and cultural operations, and for the sake of brevity I have omitted all reference to control of plantation work and silviculture. This branch of control was discussed at the 3rd Silvicultural Conference at Dehra Dun in March 1929 (item 17), and the papers and resolutions adopted are available in the printed proceedings of that conference.

In conclusion, this note has been written in the hope that other provinces will also record their system of working plan control, for I doubt if there is any other subject of equal importance where co-ordination between provinces is so conspicuously absent.

FORM NO. 29.

Felling Provisions of the Working Plan.

FOR VOLUME YIELD

Working circle.—Regular. Felling series.—Siran 1st periodic block. Area statement. Vide *paragraph.......of working plan.*

Nature of felling—Regeneration fellings. vide *paragraph......of Working Plan.*

Units to be marked annually.—450,000 cft. A deviation exceeding ±10%, *i.e,* (45,000 cft.) requires previous sanction of C. C. F.

SUMMARY OF UNITS MARKED.

Year.	Units marked.	Excess or deficit.	Running excess or deficit.	REMARKS.
1923-24	378446	—71554	—71554	Deviation sanctioned under C.C.F's No...dated..
1924-25	494157	+44157	—27397	
1925-26	472413	+22413	-4984	
1926-27	418624	—31376	—36360	
1927-28	522656	+72656	+36296	
1928-29	387787	—62213	—25,917	
1929-30	474641	+24641	—1276	
1930-31	591266	+141266	+139,990	Excess felling sanctioned under C. C. F.'s No.—— dated
1931-32	266394	—183606	—43616	
1932-33	297251*	+13751*	—29865	* Yield reduced to 283500 by C.C.F.'s Order No.....dated....

FORM NO. 29A.

Result of Fellings.

Year of working and locality exploited Block and Compt.	Trees marked.					Remarks.
	Spp.	Diam. class.	No. of trees.	Unit factor.	Volume in units or cu. ft.	

FORM NO. 29B.

Control for Area Yield.

Working Circle.—Regular. Felling Series.—Siran Range. Periodic Block—Unallotted.

Nature of fellings and Working Plan prescriptions. Thinnings, vide *paragraph......of Working Plan.*

Prescribed.				Result.	
Year.	Coupe No.	Localities prescribed Block and Compt.	Acreage.	Year (s) in which actually felled.	Remarks.
1923-34	I	Baz Khanl (*ii*)	123	1924-25.	Not worked in 1923-24 due to no demand. Deviation requires C. C. F's sanction.
		Tanglai 1 (*i*)	134		
		,, 1 (*ii*)	126		
		Massar 10 (*i*)	64		
		Massar 11 (*i*)	214	1923-24.	
1924-25	II	Tanglai 2 (*i*)	153	1924-25	
		,, 2 (*ii*)	249	1925-26	Deviation sanctioned under C.C.F's No............ dated..........
		Massar 11 (*ii*)	216	1924-25	
		,, 9 (*i*)	236	1924-25	
		,, 9 (*ii*)	189	1926-27	Deviation sanctioned under C.C.F.'s No. .... dated......
		,, 9 (*iii*)	219	1925-26	Deviation sanctioned under C.C.F.'s No..... dated........

FORM NO. 29C.

Provisions of the Working Plan Regarding Subsidiary Operations.

Working Circle.—Regular. Felling Series.—Siran. Periodic Block.—1st.

Nature of subsidiary operations—

(1) Prescribed annually: Cultural operations and slash disposal to be carried out in P. B. I in the year after the main regeneration fellings. *vide* para ....of Working Plan.

(2) At the discretion of the D. F. O.—None.

CONTROL OF SUBSIDIARY OPERATIONS.

Year.	Prescribed. Coupe No.	Localities prescribed Block and Compt.	Acreage.	Result. Year (s) in which actually worked.	Remarks.
1923-34	..	Areas felled in 1922-23.	700	..	Not done due to lack of funds.

FORM NO. 29G.

Statement showing Deviations from the Prescriptions of the Working Plan.

Year—1923-24. *Division.*—Garhwal.

Serial No. of deviation	Control book, name, form and page.	Reference to Working Plan. Paragraph.	Nature of prescriptions.	Nature of deviation requiring Chief Conservator's sanction.
1.	Control of volume yield form 29, page 1	159	P. B. I yield of 450,000 c. ft. p.a.	Deficit felling of 71,554 c.ft., already sanctioned in C. C. F.'s No.....dated..
2.	Control of area yield form 29B, page 3.	167	Thinnings prescribed yearly.	4 Compartments not thinned due to no demand. C. C. F.'s sanction required.
3.	Control of cultural operations form 29C, page 4.	174	Cultural operations and slash disposal to follow the main fellings in P. B. I	Not done due to lack of funds, C. C. F.'s sanction required.

Countersigned
C. D.
Conservator of Forests,
Kumaon Circle.

(Signed) A. B.
Divisional Forest Officer.

Forwarded to the Chief Conservator of Forests, after check. Deviation No. 1 has already been sanctioned and No. 2 may be sanctioned. Deviation 3 is presumably due to financial crisis, and requires consideration.

(Sd.) E. F.,
Conservator of Forests,
Working Plans Circle, U. P.

Deviations sanctioned with the remark that no orders have been issued to neglect cultural operations in P. B. I. and funds must be provided in future.

(Signed) G. H.
Chief Conservator of Forests, U. P.

SIMPLER CONTROL FORMS, A REPLY.

By H. L. Wright, B.A., I.F.S.

My article in the *Indian Forester* for April on simpler control forms has resulted in another article from Mr. Smythies on the same subject, in which he describes the system of control and control procedure at present in use in the U. P. The fact that this province has, for the last six or seven years, abandoned the standard forms given in *Practical Forest Management* will come as a revelation to many of us, who have been inclined to think that the chapter on " Control " was almost the last word on the subject. Some of us too will feel that we have a grouse against the joint author who, having evolved something so much simpler and so much less laborious to prepare, has kept this a close provincial secret and left the rest of us to continue our struggles with Form 2A.

That the present U. P. forms are an enormous improvement on any system of control hitherto attempted cannot be denied, but whether they are suitable for general application is another matter. This depends very largely on the purpose the forms are intended to serve. The U. P. territorial Conservator is in the happy position of having " no responsibility or trouble over control forms ", but in these days few provinces can afford the luxury of a Working Plan Conservator and in most circles it is the territorial Conservator who is primarily responsible both for the control of the working plan and for the preparation of the control forms.

Now the U. P. forms are good as far as they go ; they almost automatically display deviations and they provide a purely arithmetical check on the work that has been done. But is this enough ? Are the forms of any use to the controlling officer when he inspects the forests ? An examination of the forms will provide a negative answer to both these questions. The forms are excellent for office control, but useless for anything else.

This brings us to a question which must be answered before further discussion can be entered into. For what purpose are control forms prepared ? Are they merely to enable the Chief Conservator to

check and to sanction deviations, or are they to assist the Conservator to control the execution of the plan ? The U. P. forms were apparently designed for the first purpose, mine were definitely prepared for the second. A comparison of the two forms, U. P. form 29 and my form A, both of which have been prepared for the same working plan, will bring this out more clearly.

The U. P. form merely tells the controlling officer that at the end of 1932-33 the fellings were 29,865 cubic feet in arrears. From form A, on the other hand, he can see at a glance, without having to hunt through a bundle of compartment histories, exactly what has been done during the course of the plan ; which compartments have been felled over ; which remain for working ; which have been gone over more than once ; how much of the original stock has been removed. The actual position of the plan is at once brought home, which in this particular case is that although arithmetically in arrears, there is actually only one compartment left in which to make a seeding felling ; that several compartments have already been felled more than once and that in a year's time fellings are likely to come to a complete standstill.

Mr. Smythies criticises this form on the grounds that there are 61 entries which are merely repetitions of entries in previous columns and that in 1932-33 the D. F. O. has to enter 33 figures in form A as compared with 3 in form 29. But even assuming that the D. F. O. is a slow worker, the entering up of 30 more figures should not take more than ten minutes, which would be time well spent in obtaining a whole-plate enlargement instead of a V. P. K. snapshot of the work under the plan.

Mr. Smythies also carefully ignores the work involved in filling up form 29 A, which is an essential part of his form 29, as it contains "the necessary data to check col. 2." Every compartment in which a tree has been felled has to be entered in this form, as well as details of all the trees marked, and the filling up of this form must involve far more labour than making 30 more entries in form A.

Turning now to control by area, it must be admitted that the U. P. form 29 B is much better than the suggested form B, though

here again simplification appears to have gone too far. For it requires pencil and paper to work out from this form the actual deviation in acres at the end of each year, and an additional column should certainly be provided to show this. Whether the volume removed should be given a place in this form is a moot point. Personally, as a controlling officer, I should like to see the volumes entered. Cases are not unheard of where a revenue hunting D. F. O. has used a thinning prescription to cloak a fairly heavy felling and if the volumes removed are entered in the control form it would be far easier to check this kind of thing. The total volume removed during a year would also give some indication of how much of the yield was being obtained from fellings without a volume control, an important point which is apt to be lost sight of.

One of the soundest features of the U. P. procedure, which appears difficult to improve upon, is making the working plan officer responsible for the initial preparation of the control forms. This should save considerable trouble in future years, and I write feelingly having just spent the best part of two days in attempting to straighten out the control forms for a plan which I was eventually forced to decide was impossible to control in its present form.

In conclusion, I should like to endorse Mr. Smythies' plea that other provinces should also record their system of working plan control, for the simplification of control forms is such an important matter that even if these articles lead to nothing else they will have served their purpose if other people now record their ideas and so enable the subject to be discussed from all points of view.

A CONTRIBUTION TO THE GEOLOGICAL HISTORY OF THE DIPTEROCARPACEAE.

By Dr. Helen Bancroft.

(*Reprinted from Geologiska Foreningens I Stockholm Forhandlingar*, 1933).

Dr. Bancroft has carried out this piece of research work at the Imperial Forestry Institute, Oxford, not as a regular member of the staff but as a private worker under a grant from the Christopher Welch Trustees. It is advisable to make this clear, firstly, in order to remove any criticism that work paid for by government grants to the Institute is of too academic a character, and secondly, to show that the Institute in spite of inadequate financial support is attracting outside scientific workers to it.

The paper is based upon the discussion of certain fossilised timber specimens which were found on Mount Elgon, an extinct volcanic centre on the borders of Kenya and Uganda in equatorial Africa. A careful analysis of these specimens and a comparison with present day timbers has shown that they are undoubtedly dipterocarps. They are closely related to the genus *Dipterocarpus* itself and nearest to the section which includes *D. tuberculatus*—*D. turbinatus*—*D. pilosus*, sharing with them the characteristics of secretory canals with vessels occurring in short tangential series as well as singly, and producing an oleoresin which has actually been recovered from these fossil specimens. The rays are heterogeneous, commonly from 1 to 5 seriate, and are thus unlike the only two African dipterocarpus of the present day, namely *Monotes* and *Marquesia* which are apparently uniseriate throughout and which also have no secretory canals. In the case of fossil wood elements the actual measurement of size is not a very reliable criterion for identification with present day species and more attention is consequently paid to their structure, general proportion, and distribution, than to their size.

The present day distribution of the 350 species of Dipterocarpaceae is tropical Asia, *i.e.*, India, Burma, Ceylon, Malaysia, Philippines, Moluccas, Celebes and New Guiana. Beyond this there is one species

in the Seychelles and the two African species mentioned above. There are no extra-tropical representatives nor any in tropical Australia or tropical America. The family seems to have reached its maximum development in number of genera and species in Burma and Malaysia as gregarious trees at low altitudes, but of the many genera *Dipterocarpus* itself is the most widely spread. As the typical two-winged seeds are not adapted to water distribution the author postulates a centre of origin in Western Malaysia in early Tertiary or late Mesozoic times, when this area was still a continent and had not yet been broken up into scattered islands. Migration took place eastwards to the Philippine area, and northwards through Burma, thence into India and into Africa, either *viâ* the land bridges which then existed, or *viâ* the Arabian area. With the severance of Africa from India and the increasing aridity of the Arabian area the western and evidently the least virile extension of the dipterocarp group became isolated in Africa. The complete absence of dipterocarpus from Madagascar indicates that this area was separated from India (if it ever was joined to it) before migration could take place, and that the route from India to Africa must have been a more northerly one. The fact that Mount Elgon, the source of these new fossils, is considerably north-east of the present day distribution of the family in Africa, strengthens this presumption. The African branch of the family is a dying one and the author points out a possible parallelism between the African and Indian representatives in this respect, because of the fact that Ceylon possesses more species and genera of dipterocarpus than does the whole of India, the inference being that India may formerly have supported a much richer dipterocarp flora than it does to-day.

R. M. G.

THE PHYSIOGRAPHY OF BURMA.

By H. L. Chhibber, D.Sc., F.G.S., F.R.G.S.

Geological Survey of India, formerly Head of the Department of Geology and Geography, University College, Rangoon.

This little book is an elaboration of the author's lecture notes written and used by him for teaching in the University of Rangoon. It tells in an interesting and lucid manner the story of the evolution of the present physical features of the country, explaining to the student how these features are but the surface expression of its geological history and structure. Chapters are devoted to the main physical features, the mountain and river systems, the lakes, volcanoes, coast line, etc., and to the forces of nature which build up and wear down the surface of the land. There are many illustrations, and references to further literature are given for the benefit of those who desire to study the subject further. It is perhaps true that only a small percentage of the students that pass through the Universities realise the valuable rôle that the presence of vegetation, especially of forests, plays in the conservation of water supply and in the prevention of erosion and of floods with their destructive consequences, and it is therefore pleasing to note the author's emphasis of the beneficial effects of the preservation of forests and the ill-effects of the removal of its protective covering, especially by uncontrolled *taungya* or shifting cultivation, which "should be strictly regulated or prohibited, as the vested interests in the hills are but small compared with the vast interest at stake in the rich plains below." But it is not only by students at the university that the book should be read; it will provide much interesting reading for the forester, the naturalist, sportsman, miner, planter or settler and for all those who are interested in the geology and geography of the country. It will add interest to their travel, tours and excursions, whether they be to the defiles of the Irrawaddy, the Gokteik gorge, the mud volcanoes of Minbu or the limestone caves of Moulmein, and will help to a better understanding and appreciation of the profile of this most interesting and fascinating land.

C. E. P.

CORRESPONDENCE.

FORKING OF TEAK PLANTS.

I have read with interest the note on forking of teak plants but do not agree with the writer of the note referred to in the Editorial Notes of January 1934 of the *Indian Forester*. The tendency of the forking of teak plants referred to in my article of June 1933 was observed not in forests open to grazing but in a plantation effectively protected against grazing and browsing, as it has been protected with costly woven and barbed wire fences against cattle and deer. There can be no question of damage by cattle, by trampling, nibbling or by rubbing, as no cattle could get inside the fenced areas. As a matter of fact no cattle have so far set foot in the areas since their formation. The note has, however, confirmed my belief that the cause of forking is due to damage by frost to the tops of plants. This again goes to prove the undesirability of creating large clear fellings or frost holes, as the same is being observed in the *sal taungyas* where *sal* seedlings are being badly damaged by frost. This frustrates the idea of putting much faith on the small *sal* seedlings raised in *taungyas* on which working plans are being based. In order to avoid frost damage we must have standards in sufficient numbers to break up the frost level, and must not resort to clear fellings.

J. K. PANDE,
(*Rai Sahib*).
Forest Ranger, U. P.

24th February 1934.

EXTRACTS.

SUMMARY OF LOLAB WORKING PLAN, 1934—1943.

This Working Plan is a revision of the old Lolab plan by B. Sher Singh that introduced the Uniform system for the first time in the Kashmir forests 10 years ago and has been revised by Mr. R. L. Khajuria, Dipl. I. F. S. The total area covered by the plan is about 125 sq. miles comprising the entire forest area of the Lolab Valley. The forests are very valuable, not only because the major species is deodar of good quality but also because they are very compact, accessible to motor traffic, and easily workable with up-to-date and mechanised methods of extraction, *viz.*, tramways, tractors and such other machinery as is employed nowhere else in the Himalayas.

The following working circles have been constituted : --

1. The Deodar Regular Working Circle containing all the deodar and kail compartments or sub-compartments that are accessible, well-stocked, and fit for a system of concentrated regeneration under the shelter-wood compartment system.

2. The Fir Regular Working Circle comprising such fir compartments or portions thereof as are situated at comparatively low elevations and can be exploited intensively without undue exposure of the hillside, *viz.*, under the Uniform system.

Both the working circles (1) and (2) above are identical with those constituted in the last plan, except for the shifting of a few compartments from one working circle to the other.

3. The Unregulated Working Circle comprises all such compartments or sub-compartments, as have not been included either in (1) or (2) above ; but are so poorly stocked, if at all, or comparatively distantly situated, that no systematic work can be prescribed at present. This working circle replaces the High Level Selection and the Reboisment Working Circle of the last plan.

In the Deodar Regular Working Circle conversion to uniformity under the shelterwood compartment system is continued, but the basis of allotment to periodic blocks, rotation, regeneration period and yield regulation has been very much modified in the light of the latest conceptions of forest management and the local experience gained.

The rotation has been raised to 150 years corresponding to 30″ diameter approximately. A conversion period of 120 years with 4 regeneration periods of 30 years each has been adopted from the time conversion was first prescribed 10 years ago. Only the Regeneration Block (the Dark Green Block) has been definitely allotted and the compartments allotted to it are either already under regeneration fellings or have adequate advance growth in them and are fit for immediate conversion. The entire growing stock 12″ in diameter and over was enumerated and the total yield for the Working Circle was calculated on a very conservative basis. About 75% of the total yield is to be realised from the Regeneration Block and the balance from thinnings and improvement markings in the unallotted Light Green Block on a 20 years' cycle. In the Regeneration Block even aged patches up to 20″ diameter are to be retained as part of the future crop and as such, diameter classes below 20″ have been excluded in all yield calculation, nor has any increment been taken into account for the current regeneration period. No secondary or final fellings in areas already under seeding fellings are prescribed during the 10 years' period of the plan, but a systematic programme of completely stocking these areas by natural and artificial methods is laid down. Thinnings will be controlled by volume and by area check. No annual coupes have been prescribed. Only the order in which the compartments should be taken up has been indicated. To suit the local labour each year's work will be scattered in 3 blocks constituting the Lolab, while the regeneration areas have been so scattered as to cause least hardship to the zamindars in case of closure to grazing.

In other chapters there has been little departure from the older plan. While calculating the yield for the Fir Regular Working Circle increment has been ignored,

and no working has been prescribed for the unregulated working circle. Under Miscellaneous Regulations the need for compartment and fire lines and rain-gauges at range headquarters has been stressed. In the Appendices a description of the machinery in use in the exploitation of the Lolab forests by Captain Bakewell is also given.

SOCIETY FOR THE PRESERVATION OF WILD LIFE IN SOUTH INDIA.

Proceedings of the Inaugural Meeting held on Wednesday, 1st November 1933.

The inaugural meeting in connection with the formation of the Society for the Preservation of Wild Life in South India was held in the Banqueting Hall, Government House, Madras, at 5-30 p.m. on Wednesday, the 1st November 1933, with the Hon'ble Sir Archibald Campbell, K.C.I.E., C.S.I., C.B.E., V.D., I.C.S., in the chair. A large number of gentlemen from all parts of the Presidency, including representatives from the States of Mysore, Travancore and Cochin, were present. Messages of sympathy with the objects of the meeting were received from several gentlemen who were unable to attend.

In opening the proceedings of the meeting the chairman said that he had received a note from His Excellency the Governor regretting his inability to preside at the meeting owing to indisposition and asking him to read to the meeting the speech which he had intended to make. The chairman then read the following speech received from His Excellency :—

" In opening this meeting I think it will not be out of place if I give you a summary of how the idea of forming an Association for the Preservation of Wild Life in South India started. From time to time during my period of office the alarming rate at which wild life in the presidency is disappearing has been impressed upon me by many gentlemen, official and non-official, who were unanimously of opinion that, unless steps were taken to deal with the menace, wild life would soon be extinct in all but the most inaccessible forests. It was pointed out to me that a successful association had been started in the United Provinces and I was asked whether a similar association could not be established in South India. I approached the Maharajas of Mysore, Travancore and Cochin and I am very grateful to them for their offers of co-operation. The next step was to call a preliminary meeting in June last to which I invited representatives of these states and gentlemen from the presidency whom I knew to be interested in the subject. The list was, of course, by no means complete, but the meeting was sufficiently representative and unanimous to convince me that the idea was well worth trying. We decided to call an inaugural meeting in Madras and meantime to endeavour to get some propaganda on the subject going. I am greatly indebted to those gentlemen who have sent articles which you have no doubt seen in the press and I think the interest they have undoubtedly evoked is very encouraging.

" I next turn to the objects with which the association is to be formed. I expect there are people at the one extreme who think its object is the improvement of shikar

and at the other those who imagine that the association will try to stop all killing of wild animals. My own opinion is that our aim should be midway between these extremes. Certainly the interests of the cultivator in areas bordering on forests demand that the depredations of the pig, which root up his crops, and the sambhur and cheetal which graze on them should be suppressed and that his cattle should be protected from the ravages of the tiger and panther. But if pig and sambhur and cheetal are completely exterminated in any area, as they can more easily be than the carnivorous animals, then the latter will take a greater toll on the villagers' cattle. It should therefore be our endeavour to preserve a balance between the various forms of wild life.

" In past years shikar was a strenuous and often dangerous pastime. Nowadays, with the advent of the motor car and spot lights and particularly with the increase in gun licenses, a far greater number of people indulge in it and, I am afraid, many of them do not attempt to discriminate in the matter of what they shoot—hinds, immature stags and so on—and the result of this slaughter I have already predicted. What we have therefore to do is to see that the laws are tightened up, that close seasons are observed and that people are enlightened as to the consequences of their often thoughtless actions. If this is done, I can see no reason why shikar on rational and healthy lines should not go on as it did in former years. Before turning to the next phase of my subject, I will read out to you the objects of the Association for the Preservation of Game in the United Provinces :—

1. To educate public opinion and build up a sound popular opinion on the subject of preservation of wild life ;

2. To co-operate with the Provincial Governments, the Government of India, and the Indian States in saving the wild life of the country ;

3. To insist on the observance of existing rules and laws relating to game and to get them suitably amended ;

4. To take effective measures for checking unnecessary slaughter of wild life and to encourage its breeding in places where it is already reduced ;

5. To collect statistics about wild life in the United Provinces and other parts of India ;

6. To co-operate with learned men and institutions of the world interested in wild life ;

7. To establish a library on natural history and allied subjects ;

8. To encourage the study of natural history in schools and colleges ;

9. To encourage the establishment of private sanctuaries ;

10. To publish an illustrated magazine, reports and other useful literature about Indian wild life ;

11. To collect specimens of Indian wild life for learned societies and institutions of the world ;

12. To establish a national park in the United Provinces ;

13. To collect funds and arrange for grants and aids for the association ;

14. To impress on the Government of the United Provinces the necessity of forming a Game Department and fulfilling their promise, made nearly thirty years ago, of using the money collected from the sale of shooting permits for the preservation of game ; and

15. To do all that is likely to help the association in achieving its objects.

"In the rush of progress throughout the world during the nineteenth century, little attention was paid to the rapid depletion of natural assets. Large areas of forest were cut down and the animals which inhabited them were ruthlessly destroyed, and it is only within the last fifty years that any steps have been taken to stop this waste of life. More and more, however, it has come to be realized that the extermination of God's wild creatures renders man the poorer, both materially and spiritually, and I think it will interest you to hear a few facts and figures as to what is being done in other countries to preserve wild life. In the United States there are now some forty national parks where the fauna are inviolate. Similar large areas of protection have been formed in England, Canada, New Zealand and South Africa. In amost all European countries large national parks exist and in the Belgian Congo some five hundred thousand acres have been set apart for the protection of wild life. A government commission in the Federated Malay States has recently examined the state of wild life in the country and has made very far-reaching proposals for its preservation. When so much is being done in other parts of the world, it will be a blot on India's fair name if her people do not bestir themselves in this good cause and take steps to protect her magnificent fauna, once the richest and most varied in the world, before it is too late.

"I realize that in some districts, where the increasing pressure of population on the land has resulted in almost complete denudation of jungle areas, it may not be possible or even desirable to bring back the larger animals. In such areas attention can be paid to bird life, but it is of course difficult to say how far that has been and is being depleted. With regard to areas intermediate between cultivation and jungle, I have already said that it must be our endeavour to maintain a balance, having due regard to the cultivator's interests. Lastly, there are the large forest areas which are reserved and will, I hope, remain so. The possibility of converting some of these areas into national parks, where nature is left to keep the balance untrammelled by man, will be considered, and if we can find such areas accessible to our poeple, where they can go and observe the animals in natural surroundings, we shall have given South India an invaluable aesthetic asset.

"I now come to practical proposals for getting the association started. I have asked one or two gentlemen to speak after me and I then propose to read out a list of names of gentlemen whom I think would be suitable for a committee. The list is only tentative and I shall be grateful for any names which any one present may wish to suggest, but I am sure you will agree that the committee should not be made so large as to be unwieldy. It will be the duty of the committee to get together and formulate rules of the association, which will in due course have to be ratified, and they may be given the power to co-opt others as members. The question of funds looms

large, but I hope that, when we get the association started, we shall have a large number of subscribers at a small rate of subscription which will provide sufficient for our needs. I realize, however, that the collection of subscriptions will take time and that meantime funds will be necessary for stationery, postage, etc., in getting the association started. For this purpose I propose to give a donation of Rs. 300 and I hope that as many gentlemen as possible will come forward with amounts, however small, towards the initial expenses."

The Chairman next called upon Mr. B. V. Rama Ayyangar, Chief Conservator of Forests, Mysore, Mr. T. Austin, I.C.S., Dewan of Travancore, and Mr. T. Narayana Menon, Conservator of Forests, Cochin, to address the meeting. The three speakers explained the various measures adopted for stopping the indiscriminate destruction of wild life which had been going on in the States of Mysore, Travancore and Cochin and assured their hearty co-operation in the work of the society which was being formed.

THE WOODEN DOOR AS A FIRE PROTECTION TO THE MEANS OF ESCAPE.

(A Paper read at the Autumn meeting of the National Fire Brigades' Association, Eastbourne, by A. H. Barnes, F.R.I., B.A., M. I. Struct. E.

The Dual Capacity of the Fire-Resisting Door.—The functions of a door are twofold. The fire engineer naturally regards a door as something to shut, while with other people the tendency is to look upon a door as something to open. In other words a fire-resisting door is not only fire-resisting, but also a door. It is designed as a door and, as long as it exists, will probably be used as a door. It is only a remote possibility that it will ever be called upon to resist fire.

On the other hand, in the event of fire, it is the door which is the critical unit of the building in preserving the way of escape. It is true that an equivalent onus is upon walls, floors, landings and staircases, but it is the door which, owing to its functions as a door, is in the nature of things likely to be the vulnerable point in the line of defence when, for the few brief minutes, its services are so required, the importance of its fire-resisting functions may be vital—literally so.

The Suitability of Wood as a Material.—The firmly rooted general practice of constructing doors of wood may be taken as sufficient evidence that wood is the most appropriate material for the construction of the door, as a door. If in addition it is found that a wooden door can be so constructed as to afford an efficient fire-check, it is natural that the use of wood should be continued, with such modifications in actual construction as may be found to provide what is essential for the purposes of fire-resistance.

Let us consider what those essentials are.

According to the Standards Definitions and tests provided by the British Standards Institution (B. S. S. No. 476) the door must 'function satisfactorily for a specified period, whilst subjected to a prescribed heat influence,' . . . .
"the temperature on the unexposed face shall not increase at any time . . . .

by more than 250 Fahrenheit degrees above the initial temperature, and cracks, fissures or other orifices through which flame can pass shall not develop."

These words may be regarded as containing the whole duty of a fire-resisting door as a fire-resistant.

With regard to the " specified period " and the " prescribed heat influence," a natural relationship exists between the two. The characteristic points of the standard time-temperature curve for fire-resistance tests are as follows : —

	Degrees Fahrenheit.
5 minutes	1,000
10 minutes	1,300
30 minutes	1,550
1 hour	1,700
2 hours	1,850
4 hours	2,050
6 hours	2,200
8 hours	2,300

Timber is not an incombustible material, and doors designed to withstand fire of high temperature for long periods must of necessity be constructed of other materials. It must therefore be admitted at once that if wooden doors are suitable for fire-resistance, their use must be confined to positions where such duties are for short periods and relatively low temperatures, as for example, as a protection to way of escape.

What should be specified as a reasonable period during which the occupants of a building might be expected to escape is a matter requiring practical experience, and is a question for the fire expert rather than for an architect. In order, however, to provide definite data so as to enable you to estimate the resistance of wood as a material, I have had a piece tested by being subjected on one side to a constant temperature of 1,500 degrees Fahrenheit. The wood was two inches thick. After 97 minutes there were no " cracks, fissures or other orifices through which flame could pass " ; but the test was stopped at that time because failure had occurred through thermal transmission, the temperature indicated by the thermo-couple on the unexposed face having risen to the 250 degrees Fahrenheit above the initial temperature. At the end of the first hour, however, the exposed face was comparatively cool to the touch.

The wisdom of setting a limit to the permissible increase of heat on the unexposed face is, of course, obvious. The transmission of heat at a high temperature, besides being dangerous to the person, would be likely to fire any inflammable material in contact or within close proximity.

The adoption of the passage of flame as the criterion of failure is particularly appropriate to the door employed for the protection of the means of escape as, apart from other considerations, there is that of the psychological effect of the sight of fire on the behaviour of persons who may have to pass the door in the course of their escape, when a tongue of flame or even a puff of smoke may be quite enough to cause

the leaders to turn in a mad endeavour to push back past those who are still moving forward.

From the test result quoted, it might appear that a door constructed of wood nowhere less than two inches thick might be safely accepted as protection of (say) an hour. That wood is thus generally regarded as an ideal material for the purpose is evidenced by the fact that the term "fire resisting door" is generally understood to mean a door constructed of a specified wood of a given thickness.

Moisture Content and Volume.—Unfortunately wood has a trait of a detrimental nature peculiarly its own. Unlike most other materials, instead of expanding under the influence of heat, timber contracts.

All woodwork normally contains a certain percentage of moisture which varies according to the conditions of the surrounding atmosphere. The moisture content of the woodwork in an ordinary building may be taken as from 10 per cent. to 15 per cent. by weight. The actual volume of the timber increases or decreases as it takes up or gives off moisture. The volumetric variations in the direction of the grain are comparatively small, but across the grain *this change in size is a matter of* considerable moment. A piece of wood 12 inches wide, having a moisture content of, say, 15 per cent. would, if dried in an oven until the moisture was driven out, measure only about $11\frac{1}{2}$ inches in width. If damp when originally measured, the diminution would of course be greater.

With these facts in mind, let us consider the effect of a high temperature on (say) the top rail of a door, assuming the rail to be 4 inches deep originally. It would lose about 1/6 inch from its depth—that is, the bottom edge of the rail would be 1/12 inch higher and the top edge of the door 1/12 inch lower. *Allowing for a corresponding* shrinkage in the head of the door-frame, it is easily conceivable that the effect of a fire would be to create a gap of $\frac{3}{8}$ inch between the top of the door and the frame. That is assuming that the door fitted the frame accurately in the first place.

But how many doors do fit their frames accurately? The atmosphere of the timber store or workshop is usually more moist than that of the average building, and the door when made and delivered on the site may have a moisture content of 20 per cent. or more. Such a door, if hung in its swollen condition, will naturally have a space between its outer edges and *the frame as soon as it has accommodated* itself to the drier conditions of the building. The truth of this can be tested quite simply by looking at a few doors and frames.

This is not of so much moment from the fire-resistance point of view provided the door closes tightly on an ample fillet or door stop of *sufficient projection to cover* the gap, but when (as is often the case) the fillet is only $\frac{1}{4}$ inch or $\frac{3}{8}$ inch projection, this opening when augmented by the shrinakage of the door under the influence of high temperature added to a corresponding shrinkage in the door-frame, will create a clear passage for flame and smoke between the door and the *frame.*

There can be but little advantage, however, in a generous fillet to protect the space between the frame and the door unless the door is made to close tightly on the fillet. And this introduces yet another element in the problem. It has already

been indicated that the degree of shrinkage increases with the temperature. A door having a higher temperature on the one side than on the other will therefore tend to shrink more on the hotter side than on the cooler and, in the absence of sufficient restraint, will warp or belly out towards the cooler side.

A closed door is, in actual practice, usually restrained at three points, on the one side near the top and the bottom by hinges, and on the other, near the middle by a latch or lock. Now should the door be so hung as to swing towards the fire, the top and bottom corners of the door on the lock side will turn away from the frame towards the heat thus leaving a space between the two free corners of the door and the fillet. On the other hand, should the door be so hung as to swing away from the fire, the two free corners will tend to draw up close to the fillet, but the part of the door between the hinges will tend to bulge away. This distortion may not be great but it is needless to say fire and smoke require but a small opening to pass through, and once through, the opening will soon be a large one.

The outcome of all this may be stated very briefly. *Fire does not get through a door, but round it.*

The Evidence of Full-Size Tests.— This statement is not merely the result of my theorising, but is borne out in that inestimable pioneer work represented by the Reports of the British Fire Prevention Committee. Timber is a very heterogeneous material, and one does not look for uniform results from physical tests on wood, but in this one particular there is an extraordinary consistency in the conclusion of the "Red Books" dealing with wooden doors. If the British Standards Institution's criterion of failure (the passage of flame) be adopted, then it will be found that the Reports mentioned with hardly any exceptions prove beyond all possibility of coincidence that failures occur between the door and the frame (usually over the top of the door) and not through the door. In one instance (Report No. 59) the door tested was an ordinary yellow deal thin-panelled door (such as is found in an ordinary domestic building) the panels being only $\frac{5}{8}$ inch thick. The report states: —

> "In 15 minutes flame appeared over the top of door, in 16 minutes flame came through the top panel."

It will be observed that even in this case "flame appeared over the top of the door before the resistance of the $\frac{5}{8}$ inch panels broke down."

The tests of the Fire Prevention Committee were usually carried on past the point which is now recognised as "failure," and in some cases the doors were tested to destruction. Much valuable information can be gleaned from such tests. It is noticeable, for instance, that whenever the fire broke through the door itself, this point of weakness was almost invariably so placed as to point to shrinkage as the cause.

The panels, which in a door constructed to resist fire, are usually $1\frac{3}{4}$ inch or 2 inches thick, are formed with tongues around the edges which fit into grooves in the framework of the door. When shrinkage takes place, the panels draw away from the framework and the framework from the panels until the comparatively thin tongues are exposed to the fire, and time and again we read in the Reports that the fire

passed between a rail (usually the top rail) and the edge of a panel. Occasionally shrinkage betrays the thin piece of wood forming a tenon with a clear space on either side of it. That, of course, ends the test. When once the fire is through and the fire attacks the edges of the wood, complete destruction soon follows.

It is submitted, however, that practical tests, as far as they have gone, tend to indicate the possibility of a two-inch panelled door proving a safe fire-check provided that, in the making and hanging of the door in the first place, suitable precautions be exercised to counter the disabilities arising from shrinkage.

Suggested Requirements for the Construction Hanging of Fire-Resisting Doors. - Precisely what those precautions should be, one cannot say definitely without more experimental data than are at present available ; but the results of past tests suggest possible requirements which, if adopted, would tend towards the desired result.

The following are some such suggestions as might be hazarded :—

In the first place the door must of course be of sufficient thickness—say, a 2 inches (nominal) door with panels to similar thickness. Allowing for planing and finishing, this would provide a door of about $1\frac{7}{8}$ inch finished thickness.

Both the door and the frame should be constructed of kiln-dried timber of a low moisture content—probably lower than that which will be its normal condition when in use. (I know of one joinery works where the finished door has a moisture content as low as 6 per cent.).

The frame should be more deeply rebated than is the usual practice, in order to provide a fillet with a projection of, say, one inch.

The door should fit the frame where hung. If it should swell it is a simple matter to ease it, but should it shrink, the best of joiners cannot stretch it.

The door should be so hinged as to close tightly on the fillet. (Perhaps a third hinge in the middle would be an advantage in preventing the door from buckling away from the fillet.)

The door must be so secured when closed that the top and bottom of the locking style, as well as the middle, are held back tightly on the fillet of the door frame. (An ideal fitting for the purpose would be a three-way latch operated by one handle and having splayed bolts to spring into the striking plates when the door is slammed. There is probably no such latch on the market, but there soon would be if there were the demand.)

Present Conditions with Regard to the Provision of Fire-Resisting Doors.—All this may appear in nature of a Counsel of Perfection. Unfortunately, people who build, build to the minimum requirements of the Local Authority, and even then they wish the Local Authority were somewhere where fire-prevention is not legislated for. Considering the importance of the functions of the door required to preserve a means of escape, it is an amazing thing that so many Local Authorities take no cognizance of it while providing for other means of fire protection. It is still more amazing that where Local Authorities do make provision for the fire-resisting door, such a door is merely required to be of a specified thickness and of hard timber. There is no mention

of the condition of the timber, the shape of the door frame, nor even that the door should be as big as the hole which it is intended to fill. The frame may be entirely devoid of any fillet to cover the space between the door and the frame (as in the case of swing doors) nevertheless any door of the specified thickness will qualify as a fire-resisting door provided it be made of "hard timber" (whatever that may be).

The meaning of the much-used term "hard timber" is somewhat obscure. The hardness of timber is relative. Those whose lot it was during the war to sleep on a military bed will agree that any timber is hard. If, however, the term "hard timber" relates to those more expensive timbers (such as teak and mahogany) known to the trade as "hardwoods," perhaps enough has been said to show that the construction and the condition of the material are the determining factors and not the commercial classification of the timber. The test to which I have already referred in which a two-inch thickness of timber resisted 1,500 degrees Fahrenheit for 97 minutes and was still imperforate was, it should be mentioned, a piece of common Baltic fir. If further evidence be required to show the futility of any such restriction, let us again refer to the Reports of the British Fire Prevention Committee.

The Restriction to Hardwoods.—Report 26 gives details of a test on "A 2-inches framed teak door with 2-inches solid panels." The result is expressed in the following words:—

> "In 5 minutes flame appeared between frame and top rail on side of slamming style, and gradually extended along top edge and down top rail and panels."

The temperature at the time of failure is given as 750 degrees Fahrenheit.

It is difficult to attribute any special virtue to teak when these results are compared with those of the case (previously referred to) of the 2-inches deal door with $\frac{5}{8}$inch panels which resisted three times as long and failed at a temperature of 1,530 degrees Fahrenheit. Incidentally it should be observed that, while both doors were hung to open *towards* the fire, the teak door was restrained with a bolt top and bottom while the deal door was merely fastened with a mortice lock at the lock-rail.

It would be fallacious to draw general conclusions from two isolated tests; nevertheless the two tests are sufficient to prove that a deal door *can* be superior to a teak door. Further, it is proved that *if* hardwood be a more suitable material than softwood, then there must be other factors involved of such importance as to render the question of the quality of the material utterly insignificant.

The Work Before Us.—What those factors are I have endeavoured to outline as they appear to me; but of their importance in relation to one another little can be said until more research work has been carried out on full-size doors.

Some time has elapsed since the bulk of the important work of the British Fire Prevention Committee was done. The tests on the teak and deal doors just referred to were carried out in 1899 and 1900, respectively. In the reports of the tests made in those days there are no records of the fitting of the door to the frames or of the depth of the rebate, and there is, of course, no mention of moisture content or shrinkage—only the oft-repeated phrase "in so-and-so minutes flame appeared between the frame and the door."

We are now investigating the meaning behind that phrase. Where the Fire Prevention Committee sowed, others now reap. The Forest Products Research Station, the Building Research Station, the British Standards Institution, the Royal Institute of British Architects are all following up investigations which directly or indirectly are calculated to throw light on the results of the work done.

But theory without practice is like faith without works. We must have the contribution of the fire expert. The British Fire Prevention Committee has been absorbed into the National Fire Brigades' Association. In the circumstances I submit it is now for the National Fire Brigades' Association to carry on the good work.

(*Indian Engineering*, March 3rd and 10th, 1934.)

INDIAN FORESTER.

JUNE, 1934.

MANAGEMENT OF PRIVATE FORESTS.

In our current number we publish an article on the management of private forests in Bihar and Orissa. This matter has been engaging the attention of government for a number of years and we are glad to read that at last some solution of the problem has been found. In many parts of India the destruction of forests is not only of immediate loss to the local inhabitant and his descendants but goes much further afield, owing to the far-reaching effects of dessication, denudation and erosion, injuring populations which have had no hand in this work. The destruction of the forest vegetation in the foot hills of the Western Himalayas has not only impoverished the local inhabitant but has caused loss to thousands in the plains of the Punjab by the drying up of wells and the washing away of agricultural land. Chota Nagpur from being a well wooded country is a dry and scorched up land ; most of the fertile top soil has already gone, what is not washed away by water is blown away by wind with the result that the inhabitants are endeavouring to live on a largely sterile subsoil. Denudation has reduced the Sonthal Pergunnas to a miserable state and the Garo Hills are not much better.

Under the new constitution there is no forest policy for India. Every Province and every Indian State can do what they like with their forests. The public domain can be alienated by the signature of a minister. Working plans can be ignored and forest wealth destroyed regardless of the effects this may have on others. Some Indian States manage their forests on the best principles of forest management, others entirely disregard them.

In the Federation of India there should surely be some forest policy for the good of all. Yet ; none of the leaders of Indian opinion have so far interested themselves in this vital matter which is of far greater importance than many matters which have been the subject of prolonged debate. The voice of the forest officer, perhaps the only person who ever looks a century ahead, is as much heeded as the voice of a prophet prophesying evil to a wicked world.

It is for the leaders of India to see to this. Shall it be said of them all that they care not for such things !

AN INVESTIGATION OF SOME BAJRUNDI FOREST SOILS WITH REFERENCE TO REGENERATION OF SPRUCE FIR (*PICEA MORINDA*).

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I.—*Introduction.*

This investigation was undertaken at the request of the Chief Conservator of Forests, Punjab, with the object of determining differences that might exist in soils on which regeneration and no regeneration of spruce fir takes place. In one instance regeneration of deodar in addition to spruce fir was recorded.

Little work seems to have been done on forest soils of the hills in India and it was decided, therefore, to make as complete an examination as possible of soil profiles representing the two conditions. The examination, in addition to indicating the possible cause of non-regeneration, has also given information which is of interest in connection with the genetic classification of these soils. Five soil profiles have been examined, three of which represent the type of soil on which no regeneration takes place and two that on which regeneration is abundant.

II.—*Description of the Area.*

The area has already been described in some detail by Suri ([1]) from which the following has been abstracted :—

(*a*) *Situation :—*

The Bajrundi forests form a part of the Kulu forests and are situated in the inner Himalayas between north latitude 31°-23′ and 32°-26′ and east longitude 77°—77°-10′ and at a height of about 7,000 feet to 8,000 feet.

(*b*) *Drainage :—*

Kulu forests are situated in the Beas valley which runs practically from north to south. The basin of the Beas is drained on either side by a series of more or less parallel streams. The stream known as the Monalsu Khad provides drainage for the area known as the Bajrundi forests.

(*c*) *Configuration of the Ground :—*

The fir forests are situated on steep to precipitous slopes.

(*d*) *Geology :—*

The principal rocks are gneiss, shales and micaceous schist with occasional bands of granite. The soil derived from these rocks is micaceous loam or clay loam. The run-off is high as the soil lies on steep slopes.

(*e*) *Total Precipitation :—*

No actual records of precipitation in these forests are available. The only rain gauge stations in the Kulu valley are situated at Saraj, Kulu and Nagar. The normal monthly precipitation for these stations is given in Table I.

TABLE I.

Normal Monthly Precipitation in Kulu Valley.

Name of Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Banjal ..	3·06	2·89	3·22	2·34	2·27	3·64	9·03	8·99	3·58	0 81	0·56	1·15	41·54
Kulu ..	4·31	4·18	4·50	3·07	2·17	2·34	5·93	6·25	3·33	0·98	0·52	1·46	39·14
Nagar ..	5·17	5·38	6·18	3·70	2·55	2·80	7·82	7·73	4·06	1·03	0·88	1·81	49·11

Since the area is situated about 7,000 feet above sea level the precipitation occurs in two forms, in the monsoon period as rainfall, and in the winter as snow. The monsoon rainfall occurs in the months of July, August and September. The precipitation as snow occurs in the months of December, January, February and up to mid-March. This snow usually melts between mid-March and mid-April. Since the months of December, January and February and up to mid-March have the precipitation in the form of snow, the soil during this period must be regarded as dry.

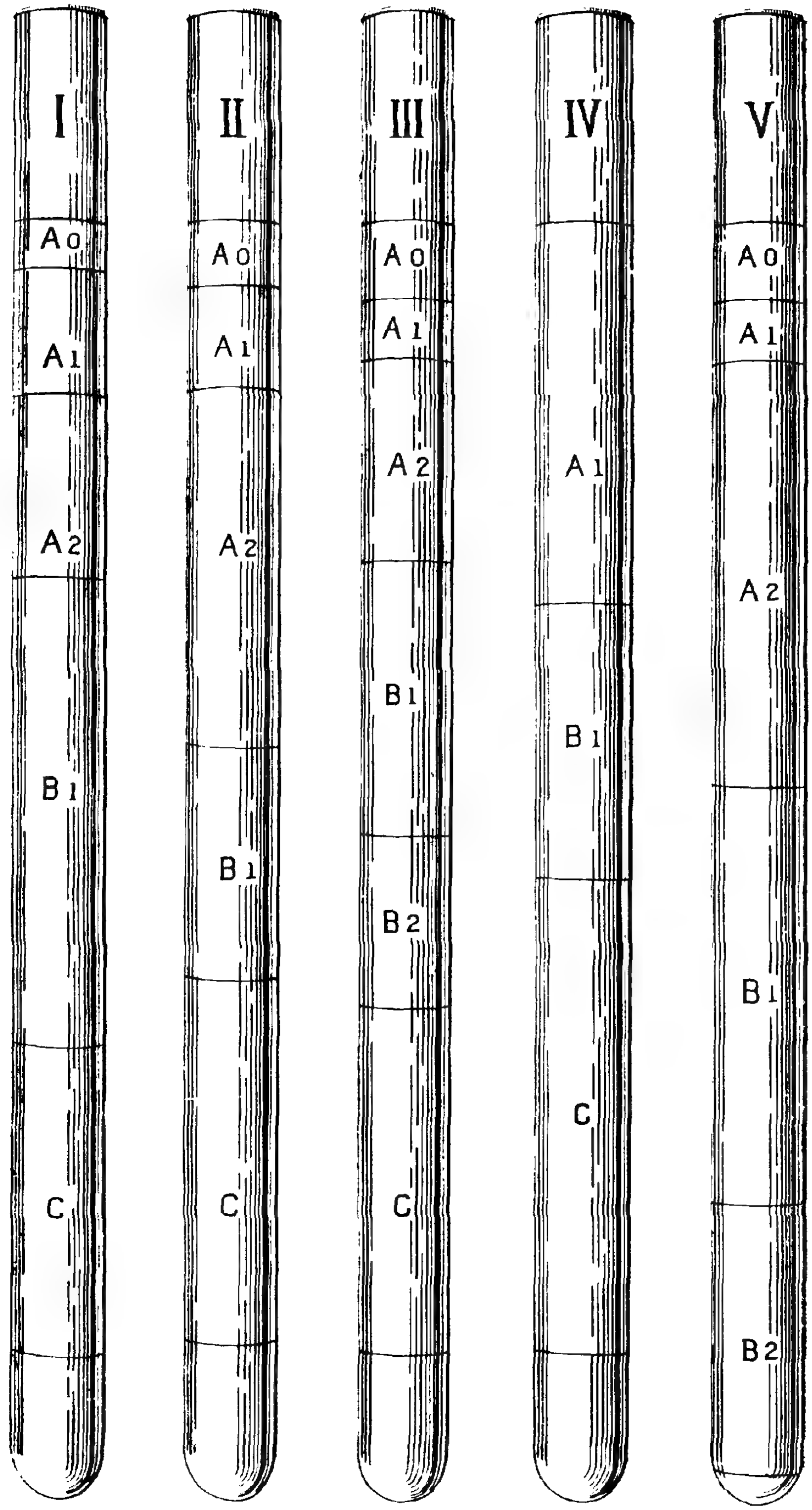
From the point of view of water supply to the soil, it will be seen, therefore, that the year is characterised by two wet periods, July to September and mid-March to mid-April, the latter due to the melting snow. Two dry periods, April 15th to June 30th and October to mid-March also occur. This distribution of wet and dry periods has not only an important influence on plant growth but also on the development of the soil profile.

From the point of view of the plant, the soil moisture conditions may be said to be suitable in the two periods, mid-March to mid-April and July 1st to September 30th. In the first of these periods germination takes place. The young seedlings have to withstand a dry period before the monsoon rainfall occurs. Germination even on non-regeneration soils is reported to be satisfactory. It appears to be the survival of the seedlings that presents difficulties in regeneration. The dry period, April 15th to June 30th, appears to be the critical time as regards the survival of the seedlings.

From the point of view of the soil profile, development processes can only be active during those portions of the year when water is available. It follows from this that the development of the profile must be a very slow process as the soil is relatively dry for a considerable portion of the year.

III.—Description and Examination of the Soil Profiles.

Of the five profiles about to be described Profiles I to III are those on which no regeneration occurs. Profiles IV and V are characterised by regeneration of spruce and deodar.



BAJRUNDI SOIL PROFILES.

Profile I was obtained from Bajrundi, Compartment No. I, 25 feet below the Bajrundi-Monalgahr Road. The hill in the vicinity was steep, had a north-east aspect and the drainage was into the Manalsu Khad. The profile was taken at an elevation of 7,250 feet. The total precipitation during the year probably amounts to 44·0 inches distributed as discussed in Section II. No regeneration occurred on this soil. There was an extensive colony of *Plectranthus rugosus* and the other plants noticed were *Galium rotundifolium*, *Ajuga* spp., *Stellaria* spp., and *Cynodon lactylon* (*khabbal*).

The profile examined is detailed below

Horizon A_0—1·5 cm. Superficial debris of undecomposed pine needle leaves and sticks.

„ A_1—6·5 cm. Brownish black humus layer with small rootlets, no defined structure.

„ A_2—15·0 cm. Less humus than A_1, stiffer than A_1; large number of roots and rootlets of *Plectranthus rugosus*.

„ B—38 cm. Soil more compact, less humus, light brown in colour, very few roots are present, small stones exist.

Horizon C—25 cm. More clay with mica, no roots, large number of stones, colour slightly yellow. Soil moist.

The results of the examination of this profile are shown in Tables II-A, II-B and II-C.

Profile II was obtained from Bajrundi 1/1, Compartment 6, just outside Indicative Plot No. III (Experimental Plot No. 32). The hill from which the profile was taken was very steep and had its drainage into the Beas river. The elevation and the total precipitation of this place are approximately the same as in the case of Profile I. There is heavy snowfall in winter. No regeneration of spruce fir occurred on this soil. Intervals between mother trees were about 30—40 feet. There was an extensive colony of *Desmodium tiliaefolium*. A fair number of *Indigofera gerardiana* were present. In addition, *Galium rotundifolium*, bracken fern, wild jasmine and *talaba* grass were noticed.

The profile examined is detailed below :—

Horizon A_0—8·0 cm. Superficial debris of undecomposed leaves. Roots of grass are visible.

,, A_1—10·0 cm. Black humus layer, powdery, structureless, numerous roots and rootlets of *Desmodium*, *indigofera* and other vegetation.

,, A_2—28·0 cm. Brownish black layer of soil containing humus slightly more compact than A_1, large number of roots and rootlets of the plants given above are present.

,, B—18·0 cm. Stiffer soil, light brown in colour. Small stones, micaceous, a few roots.

,, C—28·0 cm. Yellowish-brown sandy soil, containing roots.

The results of analysis of this profile are given in Tables III-A, III-B, and III-C.

Profile III was taken from Bajrundi I, 1, Compartment 6, adjacent to Indicative Plot No. V (Experimental Plot No. 32). The hill had an eastern aspect and was not so steep as in the case of Profiles Nos. I and II. Drainage was into the Beas river. Remarks for precipitation, elevation, etc., for Profile No. I apply in this case as well. There was no regeneration of spruce fir in this soil. Mother trees were situated at intervals of about 30—40 feet.

The principal ground vegetation was *Spiræa sorbifolia*. This is said to inhibit regeneration, but as it was absent in Profiles Nos. I and II, it does not seem to be a determining factor. Other weeds present were *Ainsliæa aptera*, *Polygonum amplexicaule*, maidenhair fern, *karash* grass and strawberries.

Description of the Profile :—

Horizon A_0— 3·0 cm. Undecomposed debris of leaves.

,, A_1—10·0 cm. Structureless humus layer with some rootlets of vegetation.

,, A_2—17·0 cm. Black humus soil with roots. Some stones were present.

Horizon B_1—19·0 cm. Grey soil containing stones and roots.

,, B_2—15·0 cm. Darker than B_1 and contains large roots.

,, C —28·0 cm. Yellowish-brown sandy soil with stones, very few roots. This horizon is moister than the preceding.

The results of analysis of this profile are given in Tables IV-A, IV-B and IV-C.

Profile IV was taken from Bajrundi I, I, Compartment 6, just outside Indicative Plot No. III (Experimental Plot No. 32). The hill had an eastern aspect and was very steep. The precipitation, elevation and drainage are similar to those of Profile I.

The regeneration of spruce fir was abundant.

Principal ground vegetation consisted of *Desmodium* and *Indigofera*. Plants of *Ainsliæa aptera*, *Polygonum amplexicaule*, maidenhair fern, *karash* grass, and strawberries were also present.

A description of the profile examined is given below :—

Horizon A_0 *NIL*.

,, A_1—33·0 cm. Brownish-black humus material containing roots and a few stones.

,, B—20·5 cm. Black humus soil containing roots.

,, C—38·0 cm. Yellow sandy loam with stones and a few roots of *Desmodium*.

The results of analysis of this profile are given in Tables V-A, V-B and V-C.

Profile V was taken from Bajrundi C, 6, at an elevation of 7,150 feet. The hill had a north-east aspect and was sloping at an angle of about 30 degrees. The profile was taken near the inspection path through the area. Natural regeneration of spruce and deodar was abundant.

The vegetation in this area consisted mostly of *Desmodium*, *Indigofera* and a little of *Strobilanthes*.

Description of the soil profile :—

Horizon A_0—6·0 cm. Undecomposed needles, grasses, etc. Dark colour.

,, A_1—6·0 cm. Partly decomposed humus, numerous roots of herbaceous flora, dark colour.

,, A_2—33·0 cm. Roots of shrubby species conspicuous, somewhat lighter in colour than A_1.

,, B_1—33·0 cm. Brownish or yellowish-brown in appearance, contains large stones. Rootlets of spruce noticed.

,, B_2—28·0 cm. Very slightly darker than horizon B_1. Contains roots of spruce. Moister than B_1.

,, C Not received.

The results of analysis of this profile are given in Tables VI-A VI-B and VI-C.

IV.—Discussion.

From the examination of the organic matter and moisture contents of the A horizons, it will be seen that a high organic matter is associated with a high moisture content of the air dry material. This relationship between organic matter and moisture content appears to die out when the organic matter present in a horizon amounts to 11 per cent. or less. In the following table are shown the depths of the A horizons in each profile which have an organic matter content of above 11·0 per cent.

TABLE VII

Profiles.	I.	II.	III.	IV.	V.
A_0					
Organic Matter ..	37·55%	43·35%	32·55%		20·94%
Moisture ..	10·05%	10·88%	6·18%		3·96%
Depth in cms. ..	1·50 cms.	8·0 cms.	3 cms.		6 cms.
A_1					
Organic Matter ..	24·49%	26·75%	15·85%		
Moisture ..	6·06%	7·34%	4·74%		
Depth in cms. ..	6·50 cms.	10 cms.	10 cms.		
A_2					
Organic Matter ..	18·67%	18·05%	12·0%		
Moisture ..	3·18%	2·91%	3·37%		
Depth in cms. ..	15 cms.	28 cms.	17 cms.		
Total depth in cms. of A Horizons with Organic Matter Content of 11 per cent. and over ..	23 cms.	46 cms.	30 cms.		6 cms.

From Table VII it will be seen that in the case of the profiles of soils in which no regeneration occurs the depths of the horizons which contain above 11·0 per cent. organic matter is very much greater than in the case of those profiles upon which regeneration takes place. This striking difference in the profiles suggested the further examination of the organic matter of these horizons. A determination was made of the amount of water which the organic matter of these horizons could hold. It was shown that the A_1 horizon of profile No. II could absorb an amount of water equivalent to 54·0 per cent. of its dry weight. This indicates that those horizons with high organic matter content, since they are situated near the surface of the soil, will retain a considerable proportion of any water that may be added to the soil surface. As a result of this, it is unlikely that water will penetrate to any great depth in such a soil. It appears, therefore, that the soil with high organic matter content in its surface layers will be moistened only to a slight depth and that this water will be liable to rapid removal by evaporation during a dry period. Since it has also been shown that this type of soil has a considerable content of moisture when in the air dry condition, it appears that a large proportion of the moisture added to the soil will be unavailable for the plant.

The bearing of these observations on the question of regeneration appears to be that if the seedling has not made sufficient growth before the soil dries out, the roots will remain in a layer of peat containing unavailable water. As the melting of the snow is followed by a period of high temperature with little rainfall the seedling is unlikely to survive. If the zone of high content of organic matter is of shallow depth only, then, on the moisture available from the melting snow, the root development can be such that it can penetrate to the underlying soil layer. From the analysis it will be seen that the B horizon in all cases has a low moisture content in the air dry state and consequently a high factor of moisture availability for the plant. From the results obtained, therefore, it is suggested that the depth of the layer of high organic matter content, on account of its behaviour to water, is the determining factor in regeneration. From the small number of profiles examined it is impossible to determine definitely the limiting

content of organic matter for regeneration but an extension of this investigation would probably lead to a conclusion on this point.

The soil profiles can also be considered from the point of view of their genetical classification. Dealing first with soil Profiles IV and V it will be seen from the analysis that they fall into the podsol group.

Robinson$_2$, Joffe and Watson$_3$ give a detailed description of the podsol profile. It is characterised by three horizons as follows :—

A. An elluviated horizon,

B. A horizon of illuviation which is enriched by constituents leached from the A horizon.

and C. The parent material.

The A horizon is characterised by its high content of organic matter, its high exchange capacity and a high content of replaceable bases. These bases are derived from the organic matter which is annually added to the soil. The A horizon has therefore a high degree of saturation. Usually there is an A horizon in a well developed podsol which consists of a bleached layer. In none of the profiles under discussion was the bleached layer present. The profiles must, therefore, be regarded as immature podsols. To some extent this would be expected from the distribution of the wet and dry periods, the soil forming processes being slow under these conditions.

In soils belonging to the podsol group, the characteristic of the B horizon is the accumulation of sesquioxides. That such has occurred in the profiles under examination is shown by Tables V-C and VI-C. The ratio SiO_2/R_2O_3 in the B horizon demonstrates that the sesquioxides are higher in this region than in either the A or the C horizons.

A further characteristic of the B horizon is its low degree of saturation compared with that of the A horizon. This is brought out in Tables V-B and VI-B. The pH values of the B horizons are also lower than those of the A or the C horizons, *i.e.*, the tendency of B horizons is to develop a more marked acid reaction. It will be seen that all the horizons of the profiles are acid in reaction. With reference to Profiles I, II and III, as the A horizons are very deep, illuviation will be relatively small owing to the retentive power for water of

the organic matter. As a result of this it would be expected that the degree of podsolisation would be lower in these soils than in Profiles IV and V. There is undoubtedly a certain tendency for illuviation to take place, but both from the SiO_2/R_2O_3 ratio and from the pH values it is not so marked as in Profiles IV and V. From this it seems that the conditions which determine the rate of accumulation of the A horizons also determine the degree of podsolisation.

Summary.

1. A series of soil profiles representing areas in which regeneration and no regeneration of spruce fir takes place has been examined.

2. Areas in which no regeneration takes place appear to be characterised by a deep A horizon of high organic matter content. Areas in which regeneration takes place are characterised by a shallow A horizon of high organic matter content.

3. The properties of the A horizons have been examined and it has been suggested that, as a result of their high water holding capacity and the large amount of unavailable water, the seedlings do not have sufficient moisture throughout the A horizon to enable them to carry over the dry period following the melting of the snow.

4. The soils examined have been shown to belong to the podsol group. As there are long periods of drought during the year they are immature podsols.

5. The depth of the peat layer appears to determine the degree of podsolisation.

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2. Robinson, G. W. .. "Soils. Their Origin, Constitution and Classification" Thomas Murby & Co., London.

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Mr. Mehta Mukand Lal undertook the field work in connection with the collection of the soil profiles discussed in this paper and was responsible for their description. Mr. Rattan Chand Hoon has carried out the examination of the profiles in the Laboratory. The preparation of the paper has been the joint work of the authors.

BAJRUNDI FOREST SOIL PROFILES.

Statement of Analytical Results of Profile I.

TABLE II-A.

Mechanical Analysis (per 100 gms. of air dry soil passed through 1 mm. sieve).

		A_0	A_1	A_2	B	C
Organic Matter	..	37·55	24·49	18·67	5·29	2·91
Moisture	..	10·05	6·06	3·18	2·47	1·88
Sand	..	12·30	13·94	15·47	18·14	18·88
Fine Sand	..	10·31	10·60	12·68	12·70	16·53
Silt	..	15·70	12·00	13·40	15·15	33·80
Fine Silt	..	13·10	20·70	25·60	32·95	23·90
Clay (·001)	..	1·60	12·10	11·80	13·40	2·64
Total	..	100·61	99·89	100·80	100·10	100·54
Difference	..	+0·61	−0·11	+0·81	+0·10	+0·54

TABLE II-B.

B (i) pH of 1 : 5 Soil-Water Suspensions determined with glass electrodes apparatus.

pH	..	5·95	6·18	6·21	5·98	5·92

B (ii) Exchangeable Bases (Results given in milli equivalents per 100 gms. of air dry soil).

Na	..	Traces.	Traces.	Traces.	Traces.	Traces.
K	..	,,	,,	,,	,,	,,
Mg	..	6·54	5·87	6·08	5·68	1·87
Ca	..	45·54	40·15	32·38	12·41	3·54

B (iii) Total Exchange Capacity (Results given as milli equivalents per 100 gms. of air dry soil).

Total Exchange Capacity..	52·55	47·00	38·50	19·30	9·30

TABLE II-C. (CLAY ANALYSIS).

Percentage R_2O_3 obtained by using molecular ratio of % Fe_2O_3 and Percentage Al_2O_3.

% SiO_2	..	19·04	37·93	31·65	27·32	36·22
% R_2O_3	..	39·80	32·35	22·11	27·10	23·16
SiO_2/R_2O_3	..	0·48	1·14	1·43	1·00	1·56

TABLE III-A.

Mechanical Analysis (per 100 gms. of air dry soil and passed through 1 mm. sieve).

	A_0	A_1	A_2	B_1	C
Organic Matter ..	43·35	26·75	18·05	6·91	3·78
Moisture ..	10·88	7·34	2·91	1·47	3·36
Sand ..	6·20	30·74	25·39	35·19	33·41
Fine Sand ..	8·04	10·30	15·45	22·05	20·28
Silt ..	14·90	10·60	12·90	10·70	13·90
Fine Silt ..	12·06	16·70	18·10	15·10	15·20
Clay (·001) ..	4·44	9·50	6·60	8·60	9·70
Total ..	99·87	100·93	99·40	100·02	99·63
Difference ..	−0·13	+0·93	−0·60	+0·02	−0·37

TABLE III-B.

B (i) pH of 1 : 5 soil water suspensions determined with glass electrode apparatus.

pH ..	6·76	7·01	6·79	5·82	5·32

B (ii) Exchangeable Bases (Results given in milli equivalents per 100 gms. of air dry soil).

Na ..	Traces.	Traces.	Traces.	Traces.	Traces.
K ..	”	”	”	”	”
Mg ..	9·48	5·72	4·39	3·23	3·41
Ca ..	62·95	52·11	43·16	11·62	5·99

B (iii) Total Exchange Capacity (Results given as milli equivalents per 100 gms. of air dry soil).

Total Exchange Capacity ..	72·20	58·15	48·80	16·90	16·0

TABLE III-C. (Clay Analysis).

% R_2O_3 obtained by using molecular ratios of % Fe_2O_3 and % Al_2O_3.

% SiO_2 ..	15·70	37·55	41·86	48·12	42·81
% R_2O_3 ..	26·61	13·40	16·21	15·59	12·23
SiO_2/R_2O_3 ..	0·59	2·80	2·59	2·45	3·50

TABLE IV-A.

Mechanical Analysis (per 100 gms. of air dry soil and passed through 1 mm. sieve).

	A_0	A_1	A_2	B_1	B_2	C
Organic Matter ..	32·55	15·85	12·0	5·91	2·70	3·06
Moisture ..	6·18	4·74	3·37	2·75	3·27	1·06
Sand ..	17·46	24·84	28·31	34·04	36·63	38·39
Fine Sand ..	13·12	17·36	20·96	21·98	23·48	22·23
Silt ..	10·92	10·80	9·20	13·24	13·44	12·24
Fine Silt ..	11·04	18·00	18·10	15·72	14·04	16·44
Clay (·001) ..	10·23	10·30	10·20	7·00	7·00	6·76
Total ..	101·50	101·89	102·10	100·64	100·56	100·18
Difference ..	+1·50	+1·89	2·10	+0·64	+0·56	+0·18

TABLE IV-B.

B (i) pH of 1 : 5 soil water suspension determined with glass electrode apparatus.

pH	..	6·71	6·11	5·98	5·72	5·62	5·65

B (ii) Exchangeable Bases (Results given in milli equivalents per 100 gms. of air dried soil).

Na	..	Traces.	Traces.	Traces.	Traces.	Traces.	Traces.
K	..	,,	,,	,,	,,	,,	,,
Mg	..	3·77	2·51	1·62	1·43	1·08	0·54
Ca	..	51·70	27·75	23·33	15·16	13·84	8·73

B (iii) Total Exchange Capacity (Results given in milli equivalents per 100 gms. of air dried soil).

Total Exchange Capacity	..	56·00	35·30	28·30	20·00	17·38	9·80

TABLE IV-C. (Clay Analysis).

% R_2O_3 obtained by using molecular ratios of % Fe_2O_3 and % Al_2O_3.

% SiO_2	..	31·0	33·32	39·0	35·35	44·75	41·85
% R_2O_3	..	21·12	16·90	21·93	23·47	18·51	16·56
SiO_2/R_2O_3	..	1·47	1·97	1·80	1·51	2·42	2·53

TABLE V-A.

Mechanical Analysis (per 100 gms. of air dried soil and passed through 1 mm. sieve).

				A_1	B_1	C
Organic Matter	..	..	..	10·54	8·91	3·91
Moisture	..	..	..	1·77	2·08	0·97
Sand	..	..	..	32·02	45·03	52·69
Fine Sand	..	..	..	18·44	20·09	24·59
Silt	..	..	..	15·90	8·60	8·20
Fine Silt	..	..	..	14·60	9·40	7·10
Clay (·001)	..	..	..	8·30	6·50	3·50
Total	..	..	..	101·57	100·61	100·96
Difference	..	..	..	+1·57	+0·61	+0·96

TABLE V-B.

B (i) pH of 1 : 5 soil water suspensions determined with glass electrode apparatus.

pH.	..	..	..	5·62	4·80	5·49

B (ii) Exchangeable Bases (Results given in milli equivalents per 100 gms. of air dried soil).

Na	..	..	..	Traces.	Traces.	Traces.
K	..	..	..	,,	,,	,,
Mg	..	..	..	3·23	2·53	3·20
Ca	..	..	..	16·35	10·47	1·43

B (iii) Total Exchange Capacity (Results given in milli equivalents per 100 gms. of air dried soil).

Total Exchange Capacity	..	22·80	20·10	5·0

TABLE V-C. (Clay Analysis).

% R_2O_3 obtained by using molecular ratios of % Fe_2O_3 and % Al_2O_3.

% SiO_2	..	..	..	44·65	41·94	44·51
% R_2O_3	..	..	..	11·73	17·26	14·08
SiO_2/R_2O_3	..	..	..	3·80	2·43	3·16

TABLE VI-A.

Mechanical Analysis (per 100 gms. of air dry soil and passed through 1 mm. sieve).

		A_0	A_1	A_2	B_1	B_2 or C
Organic Matter	..	20·94	8·38	3·76	1·86	3·26
Moisture	..	3·96	2·06	1·12	0·45	2·24
Sand	..	24·30	38·78	41·51	46·26	47·47
Fine Sand	..	13·42	22·55	24·54	30·86	24·36
Silt	..	17·90	10·38	12·30	10·62	11·94
Fine Silt	..	14·34	12·30	12·72	8·40	7·20
Clay (·001)	..	5·94	5·82	6·00	2·34	4·86
Total	..	100·79	100·27	101·95	100·79	101·33
Difference	..	+0·79	+0·27	+1·95	+0·79	+1·33

TABLE VI-B.

B (i) pH of 1 : 5 soil water suspensions determined with glass electrode apparatus.

pH	..	7·01	6·64	6·31	5·72	4·95

B (ii) Exchangeable Bases (Results given in milli equivalents per 100 gms. of air dry soil).

Na	..	Traces.	Traces.	Traces.	Traces.	Traces.
K	..	,,	,,	,,	,,	,,
Mg	..	3·62	1·74	1·48	1·48	1·26
Ca	..	45·80	7·69	6·78	1·64	1·50

B (iii) Total Exchange Capacity (Results given as milli equivalents per 100 gms. of air dry soil).

Total Exchange Capacity..	50·09	19·8	12·45	5·0	10·40

TABLE VI-C. (Clay Analysis).

% R_2O_3 obtained by using molecular ratios of % Fe_2O_3 and % Al_2O_3

% SiO_2	..	44·75	48·41	48·50	28·42	47·43
% R_2O_3	..	15·06	18·58	17·85	34·28	12·87
SiO_2/R_2O_3	..	2·97	2·61	2·72	0·83	3·71

MANAGEMENT OF PRIVATE ESTATES FORESTS IN BIHAR AND ORISSA.

By L. R. SABHARWAL, I.F.S.

Progress in the formulation of a policy in regard to the management of the Private Estates Forests in Bihar and Orissa has been a slow one. The object of this note is to draw attention to the various difficulties and the way they were overcome, so that those who may now or in the future have to deal with this matter may have the advantage of our experience.

The history of this matter dates back to the year 1907, when the Government of India addressed all Local Governments on the subject of the relation between forests and the retention of atmospheric soil moisture. Emphasis was laid on the importance of the subject to India generally and more especially to the agricultural population whose prosperity depends to a large extent on the distribution of the available moisture not only in the form of rainfall but of the surface flow of streams and rivers. The Local Governments were requested to suggest measures to check the destruction of forests or to re-forest denuded areas, with due regard to the fact that protective measures must often affect the immediate interests of the population living near the areas to which such measures apply.

As a result of investigations carried out by the Government, it was found that there was ample evidence from all sources to prove that denudation of forests was and is still proceeding in Chota Nagpur at a pace that threatens the extinction of the forest area within a limited time, and there is good reason to believe that of recent years the rate of destruction has been progressively accelerated.

The Government realised that in an agricultural country inhabited for the most part by aboriginals the denudation of forests was also a great economic danger. The free or cheap supply of wood so necessary to an agricultural population would come to an end, the grazing area would diminish and the cattle would suffer severely. Wood being no longer available for fuel, cowdung replaces it and is

lost as a manure. When scarcity occurs the aboriginal population is deprived of the fruits and tubers which have always been their reserve in such times. There were therefore two alternatives open to Government, either to accept the disaster as inevitable, or to see whether any action in the form of the restriction of the exercise of private rights was possible. The Government wisely decided to adopt the latter course. After discussing the existing provisions of law Government decided to undertake fresh legislation to provide for the preservation of forests and to facilitate or secure the afforestation of waste lands where such forests or lands were not the property of the Government. The drastic provisions of the Bill created opposition, and Government decided to abandon it and seek other means of preventing the denudation of private forests. All this happened prior to the formation of this province in 1912.

Between 1912 and 1916 applications under Section 38 of the Indian Forest Act were rare and those that were received were from the Managers of Encumbered Estates and even subsequently (2 or 3 years back), though there were many applications from the Managers of the Government managed estates, there was little inclination on the part of private owners to avail themselves of the opportunity of securing sound management of their forests. Two of the chief estates under the management of the Court of Wards have reserved or protected their forests under the Indian Forest Act and manage them on scientific lines. In others nothing has been done, not that Government did not want to do anything but there were legal and other difficulties which it was not possible to overcome.

In 1918, the Conservator of Forests, Bihar and Orissa, made a suggestion that in the use of private forests of which Government did not wish to assume direct management, reservation or protection under the Forest Act could still be applied, since " the local Government would be able to nominate the proprietor of the estate or such of its servants as they deemed fit, from time to time as a Forest Officer to carry out all or any of the provisions of the Act, and all offences could be dealt with under the Act." In the course of the same reference, the Conservator proposed that in all such cases a

formal agreement should be entered into with the proprietor to provide that the forest should be managed in accordance with a scheme to be approved by Government, and that facilities for inspection should be given. In the event of failure on the part of the proprietor to observe the agreement, Government should have the right either to assume direct management (retaining a certain proportion of the net profits) or to acquire the forests by purchase at a valuation.

On the important point of the apportionment of cost of management and the enjoyment of income the provisions were as follows :—

Government pay for the enquiry by the Forest Settlement Officer prior to the constitution of the area into a reserved or protected forest, with the exception of the cost of buying out rights of way or rights to produce and the cost of final demarcation. For these Government was prepared to advance money to be repaid in instalments without interest. The owner pays for the cost of management and staff, etc., and gets all the income from the working of the forests. This agreement laid down that "In appointing a Forest Officer, the local Government shall ordinarily have regard to the wishes of the owner."

It was however realised that as forest rights had been a source of contention between landlords and tenants for years past there was risk in investing private proprietors or their servants with powers under the Forest Act which might prepare the ground for widespread agrarian trouble. In the circumstances Government decided that powers under the Forest Act should not in future be granted to persons not under the control of Government. This scheme was applied only in one case where the Forest Officer was a Government officer whose services were given free and who had so far worked satisfactorily.

During 1925 a revised Private Forest Bill was prepared by Government but in the absence of guaranteed non-official support, it was not introduced in the Legislative Council. Government even went so far as to draw up a scheme for the acquisition of large forest areas costing several lakhs of rupees in case the private owners did not avail themselves of Section 38 of the Indian Forest Act. This scheme also did not meet with the approval of the local legislature. It will therefore

be seen that Government made every possible effort to solve the problem of preventing the further destruction of forests but has throughout been blocked by public opinion backed by the owners of private estates.

As a result of a good deal of persuasion the biggest landlord in Chota Nagpur was prevailed upon to hand over his forests to Government for management. He however agreed to do so because he was given to understand that after deducting all the costs of management he would obtain some surplus and that if the forests showed a deficit for a specified number of years he would be entitled to get his forests back. On a close examination of the forests in question it was however found that there would not only be no surplus but an actual deficit for many years to come. It was at this stage that the Conservator of Forests reported that as he saw no possibility of a profit being made from these forests for many years he considered that no useful purpose would be served by taking over the forests, merely to hand them back after a short interval. He further pointed out that the same thing would occur in the case of other estates in Chota Nagpur under the direct management of the Forest Department, if the same terms were applied to them.

After a good deal of discussion the following policy was laid down :

Government propose for the present to take over all the suitable forests in Ranchi district (which forms part of the catchment area of many of the local rivers) where the owners agree to lease them, for 35 to 40 years, to pay the cost of management, and a very small annual rent of one to two annas an acre, and to share the profits with the owner half and half.

This meant that the owner would be certain of a small rental from the forests (in many cases the owners received no income from their forests in the past), that he would incur no expenditure, and that as the forests improved, he would get something more in the possible share of profits. In the meantime, forests would steadily improve in value, and at the end of 35 or 40 years, should be of considerable value.

Before the forests are taken over by Government they will be reserved under the Indian Forest Act and the interests of the *raiyats* will be secured by a forest settlement which will settle definitely what their rights are, and the forest department will see that these rights are secured to them and nothing beyond their rights given. Government will have to pay out more than Rs. 40,000/- a year during the early years when the scheme of management of forests in Ranchi district alone is brought into effect. It is certain that the forests will gradually improve, and that the income from them will gradually become greater, and it is possible, that towards the end of the lease, Government's half share in the profits may recoup them for their early expenditure. But the actual profit is not likely to be very great, and Government will rely for a return for their expenditure, not on any actual money that may come in but on the fact that the forests have been preserved, that they have been turned into valuable property and that the owner when he gets them back, if he is wise, must see that the only way of getting an income from them is to continue proper management. To embark on a forest policy for the good of generations to come involving a loss of some Rs. 40,000/- a year, at a time of financial stringency, is a step which only a far-seeing Government would take.

While Government was busy discussing the best method of preserving whatever was left of the Private Estates Forests, the public shows its concern at the rapidly disappearing forests on the Chota Nagpur plateau, and formed the Bihar and Orissa Forest Association in 1931.

This is a private association of keen, influential and experienced men on which are represented the interests of the landlords, *raiyats* and others interested in forestry.

Its objects are—

(*a*) To foster public interest in forestry.

(*b*) To secure general recognition of the dependence of timber supply upon Forest Management.

(*c*) To endeavour to obtain an arrangement between zamindars and *raiyats* as regards the management of existing forests with a view to preventing their gradual destruction.

(*d*) To interest the public generally in planting trees, the formation of tree planting societies, and distribution of seed.

(*e*) To obtain the co-operation of Government and the Forest Department in carrying out the above objects.

It was obvious that Government policy could not succeed unless the landlords and the *raiyats* chiefly affected came to some amicable arrangement and until the Local Legislative Council voted necessary funds. Before Government brought the "Supplementary demand" before the Council, the Association arranged several meetings with the members of the Council and explained the new forest policy. It also issued some literature on the subject and distributed it to the members of the Council. The Council unanimously voted for all the money asked by Government. The Association deserves a share of the credit for this attitude towards Government's forest policy. This Association now issues a quarterly Forest Bulletin in Hindi with articles on questions connected with forestry. I have alluded briefly to the activities of the Forest Association merely to show that the Government's enlightened forest policy is obtaining recognition from public opinion, a situation much to be desired in other provinces.

Most of the landlords of Ranchi district have already agreed to lease their forests and Government are now engaged in the Forest Settlement of 60,000 acres.

INDIAN FORESTER CELEBRATES 60TH ANNIVERSARY.

BY EMANUEL FRITZ, ASSOCIATE PROFESSOR WOOD TECHNOLOGY AND LUMBERING, UNIVERSITY OF CALIFORNIA.

The *Indian Forester* started publication in the days of the celebrated foresters, Drs. William Schlich and Dietrich Brandis. Dr. Schlich was the magazine's first editor. The magazine was one of the

INDIAN FORESTER CELEBRATES 60TH ANNIVERSARY.

By Emanuel Fritz, Associate Professor Wood Technology and Lumbering, University of California.

The *Indian Forester* started publication in the days of the celebrated foresters, Drs. William Schlich and Dietrich Brandis. Dr. Schlich was the magazine's first editor. The magazine was one of the

outcomes of the Allahabad Forestry Conferences of 1873-74, and was published first as a quarterly; since 1883 it has appeared monthly. A large share of credit is given to B. H. Baden-Powell upon whose initiative the conferences were called and who was a prolific contributor to the earlier numbers.

It is worth while to quote Dr. Schlich's policy statement from the Prologue to the first volume.

> "Our object is to supply a medium for the intercommunication of ideas and the record of observations and experiments, as well as to catch all stray fragments of information, all facts and data, and supply the places of 'Notes and Queries' to the Forest Service generally."
>
> "As to our principles, they are decidedly liberal and independent. We, and all who communicate with us, are free to express what we think; we shall not repress any criticism on what we honestly believe to be wrong, or say anything that we do not believe to be true, to please any one. We shall endeavour to extenuate nothing, and we shall "set down nought in malice." But free, full and unfettered discussion of every principle and practice is the very life of forest science and forest art."
>
> "That discussion it will be our endeavour to facilitate with all the means at our disposal. But this thing we will do, we will impress on ourselves and our contributors the absolute maintenance of courtesy and good temper in the thick of the hottest discussion, and we will banish from our pages every thing that verges on personality or harshness of expression. Our criticism will be directed to measures, not men, to the opinions and utterances of the impersonal office, not to the thoughts and deeds of individuals."
>
> "In pursuance of the general principles enumerated we do not propose to open our columns to personal grievances; but questions affecting the organization of the service, or a section of the service, are legitimately within our scope. We propose to allow ourselves the option of declining papers which are unsuited for publication, or which are based on absolutely unscientific grounds;

but we trust that the exercise of this discretion will rarely need to be called into action."

"We have now earnestly to address our supporters on behalf of this new scheme of an Indian forest periodical. Above all we want steady contributors. Now many forest officers feel, and naturally so, that they have no time for writing. Others feel that they have no facility with the pen, and perhaps too modestly imagine that they can do nothing to help. With regard to this feeling, we would offer a few remarks. In the first place, while every number ought to contain a fair proportion of leisurely-written and detailed matter, that share of the work must necessarily be handed over to those who have a gift for writing, and who have the necessary literary machinery in the shape of books of reference to assist them. But the only value of a periodical of this sort will not consist in its containing elaborate essays. A large portion of it should be devoted to 'Scraps' and to brief 'Notes and Queries.' Every forest officer who is worthy the name keeps a note-book, and as some new fact or some new experience comes to his notice, or some 'happy thought,' tending to the facilitation of some portion of his work, flashes across his mind, he will make a rough note of it. There is actually no one who can go about from day to day on plantation work, up and down a river on timber transport business, demarcating a forest, making valuation surveys, or engaged in any other branch of his ordinary business, but must see something, and learn something, which is in itself valuable, and a distinct addition to the stock of facts which are the basis of all rational and practical progress in forest administration."

Dr. Schlich's statement is interesting from several angles. It sets up a policy for a magazine intended primarily to be useful to the man in the field and it indicates that 60 years ago the editor saw as his principal problem the obtaining of suitable and sufficient material for publication, the same problem that besets editors everywhere to-day. The *Indian Forester* has been eminently successful in living up to its first editor's plan and policy and it is to-day regarded by foresters in the region to which it applies as outstandingly useful. It

not only provides the 15,000 or more foresters in India and Burma with helpful information for the conduct of their work but it champions their professional interests and welfare. Its back volumes give an interesting history of the trials and successes of forestry in India, and present an enviable record of unflinching loyalty to its aims, interest, and progress.

An American forester might be amused by the frequent notes and articles on elephants, yet we must remember that the elephant is India's principal yarding engine. The elephant and teak, for example, are associated in one's mind as inseparable as ham and eggs on our breakfast menu.

The January 1934 number is the first of the 60th volume, and while a large share of this special and double number is devoted to anniversary notes and felicitations, there is the usual amount of space for other articles of such type as forestry descriptions in other British possessions: a travel article, articles on dendrology, timber framing joints, termite control, thinning out shoots on young root stocks, etc. Nor the least useful department is that of Reviews. The forester in India is here given an excellent survey of the world's literature of value to Indian forestry.

Indian foresters appear to be much concerned that the plan to provincialize the Indian Forest Service will cause the decline of forestry: whatever the outcome, it is to be hoped that they will continue the *Indian Forester* as their common forestry journal for all provinces.

EROSION IN KANAWAR, UPPER SUTLEJ VALLEY.

By Jalmeja Singh, p.f.s., Punjab.

As erosion is intimately connected with the physical and the climatic feature of a locality, a concise description of the tract and its climate therefore precedes the narration of the causes of erosion. The Sutlej River taking its source from the sacred Mansarowar Lake in arid Tibet, turns south-west at the foot of the Lio Porguil (22,210

feet) to enter Kanawar in Bashahr State. Thirty miles down it cuts the Great Himalaya Range, forming magnificent cliffs, and 20 miles further down it cuts the Dhauladhar of the outer Himalayas thus forming a gorge where it cuts the ranges, and a narrow valley of not more than 20 miles width elsewhere, till it leaves Kanawar near Sarahan (91 miles from Simla). The Sutlej thus has the narrowest of all the western Himalayan Valleys because it is the only river which cuts across the hard crystalline core of the Himalayas. And the cutting is so deep that it gives the false impression that the river flows in between two parallel mountain ranges, with massive spurs jutting out into the valley. Consequently the slopes are steep to precipitous for 2,000 feet above the river bed, followed by gentle slopes bearing cultivation and a belt of forests, and above these, alpine pastures and steep knife edged peaks varying from 18,000 to 22,000 feet in elevation. The underlying rock is biotite-granite with felspar, occurring with associated crystalline rocks like gneiss, schist, quartzite and slates, and forming unstable strata which are seen to be crumbling in exposed places ; hence the menace of landslides and treacherous falls of stones. The resultant soil is hard coarse-grained sand from granite, fine gritty sand from quartzite, and sandy loam from other rocks. The soil is dry and shallow in open places and along the river, where it is met with only in crevices on the steep cliffs. In the forests and on gentler slopes it is better and deeper.

The rainy season is short, lasting from mid-July to the end of August. There is a marked decrease of rainfall towards the interior on account of the monsoon being weakened by the barring action of the parallel ranges of the outer hills. For instance at Phancha situated at the base of the Spiti plateau, 72″ of rain out of the total of 118″ descends in July and August alone. At Kilba (129 miles from Simla) 5″ out of 16″ falls during these two months, and beyond Chini (142 miles from Simla) the monsoon is ineffective. Heavy snowfall occurs during winter and forms the main source of moisture beyond Chini. The atmospheric humidity is very low and the solar radiation is intense, causing extremes of temperature which render the soil friable. Hot winds are also responsible for desiccation of the soil during summer.

The vegetation varies with the rainfall, aspect and elevation. Below Wangtu (118 miles from Simla) the northern slopes and the side *nalas* on the right bank of the river are clothed with species of a mesophytic type. The crop is dense, the growth tall and the flora rich. In between 5,000 and 11,000 feet elevations, forest formations, more or less in belts, are met with in the following order :—

Pinus longifolia.

Pinus excelsa, Cedrus deodara, with an admixture of *Quercus incana* and *Rhododendron arboreum.*

Picea smithiana and *Cedrus deodara* with broad-leaved trees.

Abies pindrow and *Quercus semecarpifolia* with *Betula* spp. Between Wangtu and Chini the vegetation is xerophytic with the following forming stunted and open formations between 5,500 and 11,500 feet :—

Quercus ilex and *Pinus gerardiana.*

Cedrus deodara.

Abies pindrow, Pinus excelsa (high level) and *Abies webbiana. Daphne oleoides, Hippophae rhamnoides, Acer pentapomicum, Olea cuspidata, Fraxinus xanthoxyloides* and *Plectranthus rugosus* are the typical bush associates of this dry zone. Beyond Chini lies the arid zone with continuous narrow belts between 8,000 and 12,000 feet elevations of—

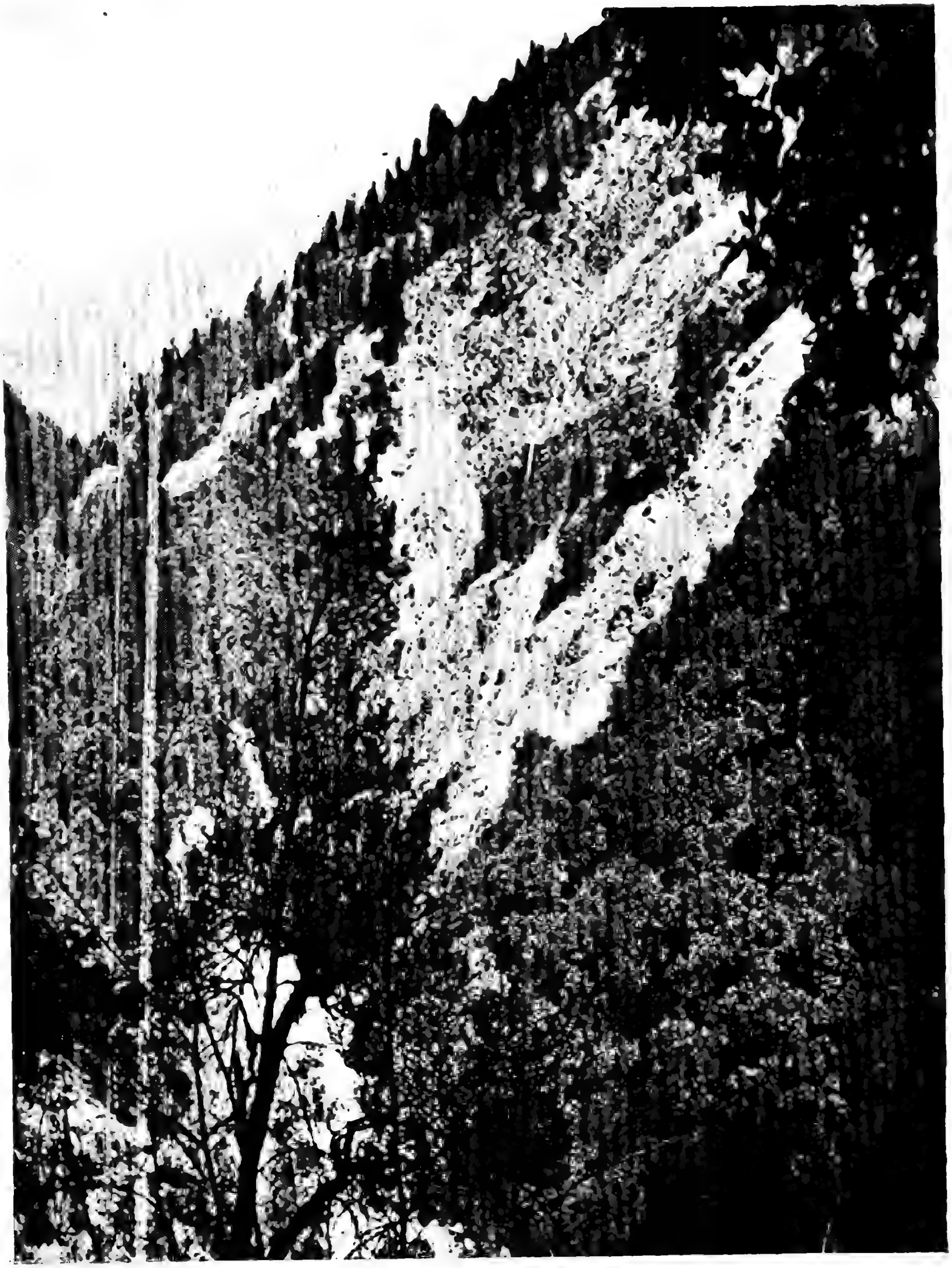
Pinus gerardiana.

Cedrus deodara.

Pinus excelsa (high level).

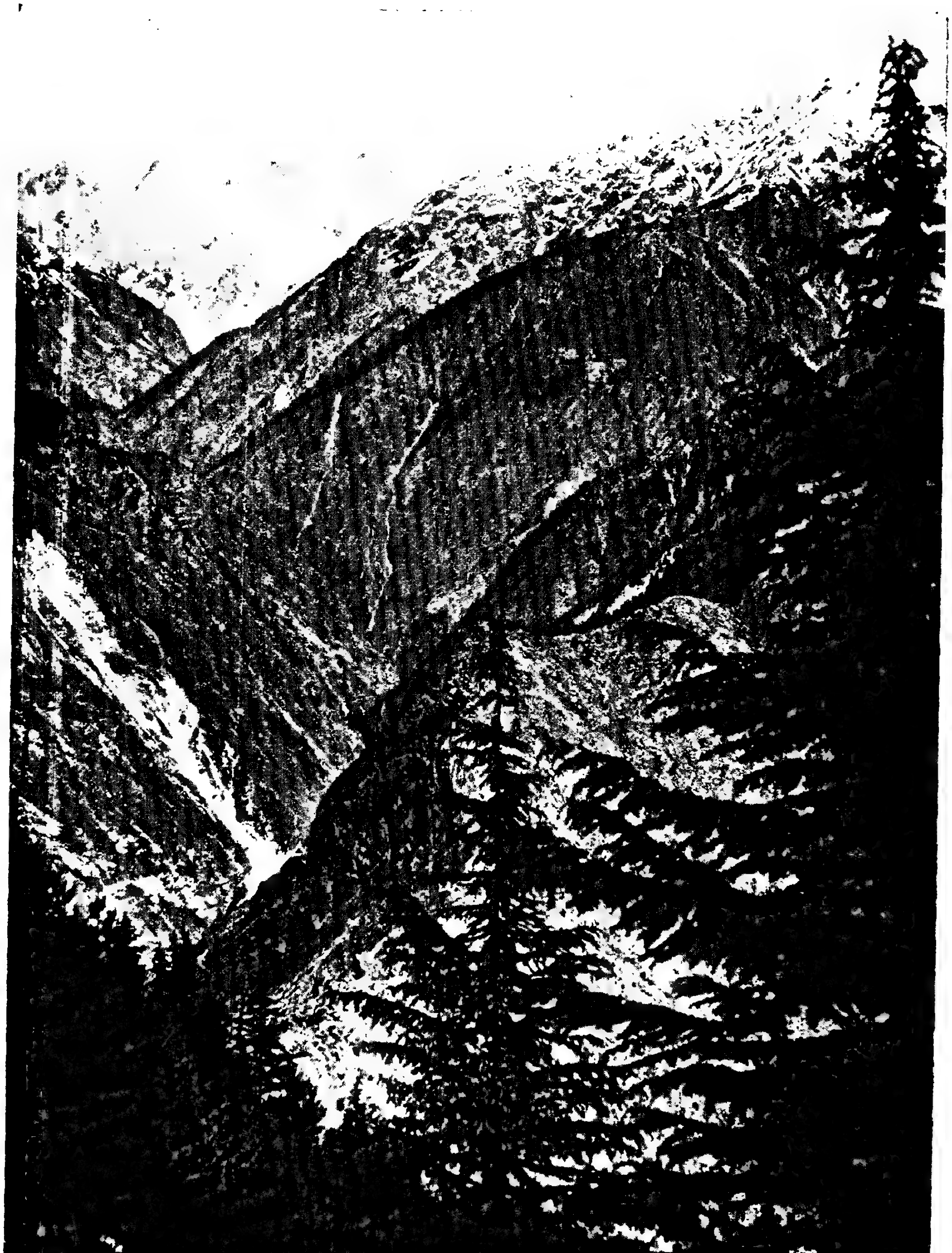
Artemisia maritima, Prunus prostrata, Ephedra spp., and *Juniperus macropoda* are the typical associates of this arid zone.

There being no vegetation worth the name in Tibet, the Kanawar forests therefore play an important part in the catchment area of the Sutlej by maintaining the subsoil water level, by mitigating the adverse effects of intense insolation and by minimising chances of landslides and avalanches. The cultivable land is very limited and is too poor to support the entire population which, though sparse, is



Old landslide being slowly reclothed with *Pinus excelsa.*
To illustrate Jalmeja Singh's "Erosion in Kanawar."

Photo: R. Maclagan Gorrie.



A fresh rock slide in the Bhabba Nala.
To illustrate Jalmeja Singh's "Erosion in Kanawar."

Photo : R. Maclagan Gorrie.

driven to live on dried apricots and on imported grain. For purposes of trade in wool they maintain large flocks of sheep and goats which are injurious to forest growth. True, the flocks mostly remain in the alpine pastures in summer, and along the river during winter, yet the grazing done on their way up and down is sufficiently destructive. Lopping is being practised on a large scale. The forest area closed to grazing, being only 2·2 per cent., is a negligible fraction of the whole tract.

The huge detritus of fine loam at the mouth of each of the Sutlej tributaries and the excessively muddy nature of the main river from March to October indicate the tremendous amount of erosion proceeding in this valley. The factors chiefly responsible for erosion are cited below :—

Soil.—The severe climatic conditions narrated above have rendered the soil soft, friable, dry and loose, and hence capable of being washed away very easily.

Slopes.—The steep slopes have led to the soil thereon being shallow and very unstable. The 88 feet per mile fall of the Sutlej is responsible for its tremendous erosive power, (its bed is some 6,000 to 7,000 feet below the beds of its neighbours, the Beas and the Giri), and for the way it has cut through the hard core of the stupendous Himalayas.

Melting of Snow.—The rapid melting of snow on account of intense solar radiation in the arid as well as in the dry zone washes down the friable soft soil at a tremendous pace.

Avalanches.—The strong winds which accompany avalanches clearfell portions of good forests, and the soil thus laid bare is eventually eroded at a faster speed.

Landslides.—On account of the steep incline of the unstable strata large areas of rock frequently slide, bringing down along with them the soil covering, which subsequently finds its way into the river in a short time.

Rainfall.—Heavy rainfall at higher elevations in the wet zone results in torrential floods in the side streams, which dislodge into the river a vast amount of fertile soil.

Grazing.—Sheep and goats eat even the leaves of young deodar and are very injurious to forest growth and regeneration. They also dislodge the soft friable soil that is easily washed down later by rain or melting snow.

Lopping.—Lopping mars the growth and shortens the life of trees. The ground under lopped trees is laid bare and becomes subject to erosion.

Crops.—The forest crop is moderately dense in the wet zone but very very poor in the arid zone on account of grazing, lopping, severe climate and exploitation. The felling refuse, undisposed of on account of financial stringency, is partly responsible for the lack of regeneration therefore the soil in many forests is in an unnecessarily exposed condition.

Remedial Measures.—As Kanawar forms no inconsiderable portion of the catchment area of the Sutlej, special attention should be given to the conservancy of the forests. The very injurious practice of lopping should be entirely stopped and attention given to the problem of excessive grazing. It is difficult, no doubt, to control the adverse natural forces, but an improvement in the condition of the forests would result in an improvement in soil moisture, soil texture and soil cover, and would reduce to some extent the rapid melting of snow, and the washing away of the soil, would break the force of heavy rain and lessen the frequency and intensity of avalanches.

The maintenance and improvement of these forests is of vital interest to the Punjab. The water in the Sutlej canals is already inadequate except at the height of the monsoon, and further decrease in the area of forest in this basin can only make matters more serious than they are already. The whole future of Punjab canal supplies is dependent on the preservation of the forests on the hills most of which belong to Indian States. This has not yet been realised by the ordinary inhabitant of the plains and until he does so forest conser-

vation in the hills will arouse little enthusiasm in political circles in spite of what professional foresters may say on the subject. It is only when the wells start drying up as in Hoshiarpur that the subject of denudation is brought home to the cultivator of the soil.

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AUTUMN *VERSUS* SPRING PLANTING OF DEODAR.

BY H. S. JAMWALL, M.F., KASHMIR FOREST SERVICE.

1. While spring planting has become not only a common practice but the general policy of the Kashmir Forest Department in the North-Western Himalaya, autumn planting cannot altogether be ruled out from the programme of artificial reproduction in regions where natural regeneration is badly lacking or is not springing up according to Forest Officers' expectations.

2. It will, therefore, be interesting to all concerned to know the comparative results of planting of one* to two year-old deodar seedlings at two different seasons in the Langet division of Kashmir Forest Circle. There seems to be no past authentic record of the results obtained in any division from autumn planting in Kashmir to guide the officer-in-charge of this operation, hence one had to

* One year old seedlings 9″ and over in height were planted.

depend mainly on one's own professional resources and keenness to take it up and determine its suitability in the forests of this region. The necessity of comparing the results of plantings in the two different seasons was particularly felt by the writer in the Lolab Valley where under the shelter-wood system blanks in the regeneration in different localities were very extensive, so that the work could not be finished in one spring, in spite of special organisation under the supervision of the Divisional Forest Officer, the Assistant Conservator of Forests and two Rangers with all their subordinate staff. In fact there are some blanks situated in depressions along the lower periphery of the compartments which could under no circumstances whatsoever be planted up in spring. Water flows here throughout the spring and the sites become too wet even to dig the pits without their being filled up to the brim with water, consequently such boggy places have to be left over for autumn planting when the soil is quite suitable for this operation.

3. The writer took up autumn planting work last year and starting it late in October, finished it in the end of December when snowfall was imminent in the valley. The work being in an experimental stage, it was carried out on almost all aspects in the four Ranges of Langet division, *viz.*, in the Northern Lolab, the Southern Lolab, the Mawar and the Ramhall Ranges.

The operation was continued under the personal supervision of the Divisional Forest Officer and the Rangers concerned and most of the work except the digging of the pits was done by the Forest Guards and Foresters; all preliminary details and the technique applied were the same as were followed in spring planting.

The following statement will show the comparative results in survival per cent. obtained in two seasons in different localities of Langet division.

Range.	Compt. No.	Aspect.	Transplanted No. of plants.	Percentage of success.	REMARKS.
			Spring planting.	%	
S. Lolab ..	50	S.	13,153	80—85	Worst spot in the Valley.
	25	W.	101,245	80—85	
	7b	E.	11,671	60—75	Planted a bit late.
	13 }	W.	10,831	85	
	14 }		5,928	70	Boggy site.
	27	N.	31,345	80—85	
		Total ..	174,173	75—81	
			Autumn planting.	%	
	25	W.	1,435	75—80	One year old seedlings above 9″ in height.
			Spring planting.	%	
N. Lolab ..	58 }	N.	7,760	94	} Well drained.
	59 }		15,911	93	
	52	b & c. E.	3,842	90	
	119 }	S.	2,436	93	
	117 }		2,507	95	
		Total ..	32,456	93	
			Autumn planting.	%	
	119	S.	804	93	
	58 }	N.	300	25	} Boggy.
	59 }		700	30	
		Total ..	1,804	48	
			Spring planting.	%	
	11a	} (1985)N	2,308	94	
Ramhall ..	11a	} (1986)	350	97	
	11a	} (1987)	1,877	82 96	
	4	N.	2,280	93	
		Total ..	6,815	95—96	
			Autumn planting.	%	
	11a	(1986) W.	848	73	
			Spring planting.	%	
	21 }	N.	207	99	
Mawar ..	22 }		400	99	
	24 }		630	96	
	32a	S.	1,800	81	
	35a	W.	50,500	99	
	23etc.	N.	3,458	97	
		Total ..	56,995	95	
			Autumn planting.	%	
	21	N.	568	93	

4. The above results are of interest as bringing out clearly two points. Firstly, as mortality shows both greatest and lowest values in different localities with similar aspects, survival of the seedlings seems chiefly to be governed more by the other factors of site than by the aspect ; thus the percentage of success from autumn planting is greatest in compartment 21 Mawar Range, and least in compartments 58 and 59 Northern Lolab Range, both being on northern aspects.

Secondly, it seems that the duration to which these seedlings are left exposed to severe winter conditions is a more important factor than the other factors of the site. For instance, the mortality is greater in compartment 11 Ramhall, in a well-drained site, than in compartment 25 Chandigam, a comparatively boggy site with a similar aspect. The apparent reason is that in the former case, the seedlings were planted in early autumn and thus were left exposed to winter conditions for a greater period, *i.e.*, about two months before they are covered under snow, while in the latter case the seedlings planted in the end of December were soon buried underneath the snow. In other words, it seems almost certain that the survival of autumn planted seedlings is in direct proportion to the length of time they were in the ground before snow fell.

5. Before the adverse factors of site that cause greatest mortality are discussed in detail for each locality, reference should be made to the probability that winter transpiration is the most outstanding factor responsible for the success or failure of autumn planted seedlings in the following spring.

6. This phenomenon of winter transpiration and its deleterious effects have very ably and elaborately been described by Mr. W. G. Wahlenberg of the United States Forest Service in the *Journal of Agricultural Research*, Vol. XXX, No. 3, wherein he states :—

> " That when plantings are made in late October the soil surrounding the roots remains at a temperature low enough to retard water intake by any absorbing surfaces left in tact by the planting act.
>
> In the meantime transpiration from the tops proceeds, the draft being made chiefly upon the moisture contained in the seedlings when planted.

Gradually the saturation deficit is increased until death or a weakened condition, which handicaps the plant the following spring, results.

The greater the transpiring surface in proportion to the absorbing surface present and able to function, the faster the drying process proceeds with its injurious or fatal results. Following spring planting, conditions are quite different. New absorbing surfaces are believed to develop after planting, thus preventing any long break in water absorption."

7. Now keeping in view the above hypothesis as a guiding principle it is quite easy to correlate the different sites and their similar aspects with success and failure of seedlings in reference to injurious effects of winter transpiration.

Thus it may be stated that the greatest mortality in compartment 58 and 59, Northern Lolab Range, may be due to any of the following causes :—

(*i*) The site is generally very poorly aerated, because the constant running water in spring keeps the interstices of the soil particles devoid of the air so essential to plants to establish themselves and thrive, and as the air in the soil particles is replaced by excessive water, a water-logged condition ensues and seedlings being unable to make any food for themselves die of starvation in summer.

(*ii*) The weakened condition of seedlings caused by intensive winter transpiration leaves them unable to function, hence the impoverished and less thrifty seedlings are unable to establish themselves in the spring.

(*iii*) The aspect being cool and shady, a water-logged condition of the soil persists throughout the summer, and consequently the seedlings succumb.

On the other hand, the success is greater in compartment 21 on a similar aspect in Mawar Range. The obvious reason is that here the site is well drained, and aspect being favourable, even the weak and infirm seedlings are able to hold their own in cool and shady places

even during the drought period in summer. As regards the success and failure in the western aspect it is evident, as already stated above, that here the time during which the seedlings were left exposed to intense winter transpiration is a more important factor than the adverse or favourable factors of site, and this is also obvious from the results achieved in compartments 11 Ramhall and 25 Chandigam in the Lolab. Both being on similar aspects, the mortality is higher in the former than in the latter which is superior in regard to the physiographic factors of the site.

On the other hand, early autumn planting in compartment 11 left the seedlings exposed to winter transpiration for a considerable period and consequently enfeebled them much more than those which were planted late in autumn in compartment 25 and covered under snow within a week. The above results are of only one year's autumn planting, hence one may not consider them final, but the writer believes that they do throw light on different factors that are important for success in our artificial plantation programme. It is hoped that the work will be repeated in coming seasons.

In conclusion it may be urged that autumn planting may also be given trial in localities where any of the following conditions prevail in the management of forests under the shelterwood system.

(*a*) Where area of failures is too great to be taken up in one season.

(*b*) Where nursery stock is abundant and the planting of the whole is impossible under certain local conditions.

(*c*) Where the scarcity of local labour in spring is keenly felt.

(*d*) Where the operation can be more thoroughly supervised at this time of the season when almost the whole staff is free from the urgent and more pressing duties involved in other silvicultural operations.

(*e*) Finally, it is specially advisable in temperate regions wher atmospheric conditions for planting are generally favourable throughout the year and where autumn planting is decidedly cheaper than spring planting provided pits are dug out beforehand in late spring.

NOTE.—[The practice of planting deodar in the spring has not been adopted outside Kashmir and this appears to be due to the peculiar distribution of the rainfall. The Lolab Working Plan published in 1933 gives the rainfall in March as 4·96″ : in April as 5·30″ : in May as 6·2″, whereas in the Punjab Himalaya these months are dry and transplants would almost certainly die. In the Lolab July, August and September have little rain, whereas in the Punjab Himalaya the rainfall is heavy and advantage is taken of the moist condition of the soil at the beginning of the S. W. monsoon to put out transplants with conspicuous success.

The common Punjab practices are (*a*) autumn sowings and (*b*) transplanting of 1½ or 2½ years' deodar plants after the first heavy monsoon rains in July. Autumn transplanting has been tried experimentally in Kulu and Bashahr and gave fair results but as they were inferior to those obtained by monsoon transplanting autumn planting has never attained much popularity.

Seed sown in autumn germinates directly the snow melts and the seedling immediately produces roots long enough to keep in touch with the receding moisture as the soil dries in the hot months of April, May and June. Some officers favour sowings: others monsoon transplanting. Both operations are eminently successful in tracts to which the monsoon penetrates: sowings alone are practiced in the dry zone of Kanawar. It may be mentioned that with the exception of the deciduous larch spring planting of conifers in Europe is the usual practice.]

H. M. G.

NATURAL REGENERATION IN THE SADIYA FRONTIER TRACT.

By L. J. Dela Nougerede, P.F.S., Assam.

As the experiment in encouragement of natural regeneration in the Sadiya division has given such satisfactory results, and applies to the type of evergreen forest comprising so large a proportion of our total forest area in Assam, an account of these evergreen forests will not be out of place.

1. *Brief history of the evergreen forests of Assam.*—Most of our so-called evergreen forests are really mixed forests comprising deciduous as well as evergreen species with an understorey of shrubs, and weeds, for the most part all jumbled together and heavily interlaced with climbers and canes, and varying in density according to whether the forest is zerophytic or hygrophytic. In the former there is a predominance of large tall trees, and climbers though present are not so prolific nor of such luxurious growth as in the latter type, while herbaceous vegetation is often absent altogether. In the latter type, owing to the abundance of moisture, canes and climbers are of prolific and luxurious growth, and the rank growth of herbaceous vegetation, constituting the perennial home of leeches whose name is legion, make such places avoided by men and beast alike, save when driven by dire necessity.

As recently as twenty years back, our evergreen forests in Assam were authoritatively pronounced to be of practically no value, while our *sal* (*Shorea robusta*) areas were considered as not only of potential value, but reckoned as almost our sole source of revenue. There was at that time, a very limited demand for a few species for local building requirements, and also a small demand for a few hardwood species such as *ajhar* (*Lagerstroemia flos-reginae*), *uriam* or *jhoki* (*Bischofia javanica*), *nahor* or *nagesur* (*Mesua ferrea*), and one or two others for sleepers for the Assam Bengal Railway, where the competitive price of *sal* was prohibitive or its use inexpedient. In any case the Forest department realised the necessity for substituting a local soft wood, easy to work and handle, and of assured supply, which after antiseptic treatment with one of the creosote compounds might meet all the requirements of the railway, and yet be less costly than *sal*. With this object Mr. (now Sir) R. S. Pearson, then Imperial Forest Economist, treated a large number of sleepers at Digboi in about 1912-15. From our point of view, *hollong* (*Dipterocarpus macrocarpus*,) though we had all along called it *Dipterocarpus pilosus* was the most important.

The Great War and its aftermath resulted in an unforeseen demand for our erstwhile neglected species and caught us unprepared. We

had previously viewed our hundreds of square miles of evergreen forest and complacently reckoned our resources almost unlimited, and bitterly lamented the dearth of demand. But the recent heavy demand for timbers from these forests, and the still more insistent demand for more revenue, has brought these forests under the microscope, so to speak, and though we had long realised that there is hardly any natural regeneration of the more important species, we were shocked to find that these forests are very poor and deficient in the more important species, which generally average only one exploitable tree in two or three acres in our reserved forests.

The growing demand for increased revenue is placing a premium on over-exploitation, and in the absence of working plans is certain to result in the impoverishment of the growing stock.

From the above it will be seen that it is imperatively necessary not merely to put back what we are removing from the forests, but generally to improve the type and stocking on an appreciable scale and in a *practical manner* commensurate with the funds at our disposal. Forestry aims at producing the ideal tree and the ideal forest, but all ideals are expensive and our resources are limited. It must be remembered that, if nature which takes no count of even life (be it animal or vegetable) in the production and fashioning of her wares, does not produce our ideal of forests or types, she has good reason for doing so. Man cannot compete with nature whose resources are unlimited. She harnesses all the forces in existence, and even man is but a vehicle for her inscrutable laws of utilizing the dead for the benefit of the living. It, therefore, is obvious that man can only at great expense and effort attempt to copy nature, so that the next best thing is to study her ways, and by artificial assistance bring about certain changes to meet our requirements.

2. *The part rivers play in soil-formation, and determination of forest types.*—Before going on to the rivers draining the district, it will be best to give a short description of the forests, and I propose dealing here with only the plains portion of the district which is so far workable.

The types of forest are :—

(*a*) High land covered with high forest comprising chiefly *hollock* (*Terminalia myriocarpa*), and its associates *khokan* (*Duabanga sonneratioides*), *siling* (*Chikrassia tabularis*), *poma* (*Cedrela toona*) *hati-paila* (*Pterospermum acerifolium*), *pichola* (*Kydia calycina*) *dhuna* (*Canarium* spp.), *bahaira* (*Terminalia belerica*), *hartaki* (*Terminalia chebula*), etc., heavily interlaced and covered with canes and climbers, found on a fairly sandy soil-with a bed of underlying boulders.

(*b*) High land with high forest consisting of *hollong* (*Dipterocarpus macrocarpus*), *nahor* (*Mesua ferrea*), *hollock* (*Terminalia myriocarpa*), *bandar-dema* (*Disoxylum binectariferum*), covered with canes and climbers, and an understorey of *toko-pat* (a species of fan palm), *gariqua* (the wild arica nut palm), species of *Arundinaria*, other bamboos, miscellaneous erect and semi-erect shrubs, and climbers. This type of forest is found only south of the Lohit river on laterite soil with a varying depth of surface humus. The sub-soil consists of conglomerate resting on a bed of boulders and sand, while occasional outcrops of clay are met with.

(*c*) On the lower portions submerged for a longer period, the annual overflow of the rivers which before drying up deposit a fine almost impervious layer of silt, we find such species as *otenga* (*Dillenia indica*), *jarul* or *ajhar* (*Lagerstroemia flos - reginae*), and other such hygrophytic species scattered among canes and climbers of every description, among a profusion of herbaceous growth.

(*d*) Recent alluvium where *Tamarix dioica* (the *jhao* plant) and coarse grasses have caught hold and prepared the way for *simul* (*Bombax malabaricum*), *kadam* (*Anthocephalus cadamba*), *Eugenia*, *Bauhinia*, and *Sterculia* species, as also an occasional patch of pure *Dalbergia sissoo* where the seed has been washed down from plants higher up and germinated after being stranded on a congenial seed-bed. This latter type of forest on alluvium soil is far from permanent, being readily formed and as readily cut away by flooding of the rivers on whose banks it springs up, so that its potential value cannot be depended upon.

The main plains portion of the district consists of the somewhat flat Lohit river valley, running from north-east to south-west of the district, about 30 to 40 miles wide with the Lohit river flowing through it. From the Lohit river the land to the north rises very gradually to the foot of the hills, which suddenly rise to a height of several thousand feet. These precipitous mountain ranges are cleft in many places forming the gorges of the following rivers :—the Digaru, the Paya, the Balijan, the Kundil, the Debong, the Dehang (which from its confluence with the Lohit is known as the Brahmaputra), and the Dijmur or Simen river. On the south side the following rivers enter the Lohit :—The Tengapani, the Noa-Dehing, the Saikhoa Jan, and the Kerua Jan.

Most of the rivers on the north side are snow fed and of great magnitude. These rivers are the arteries of our province and of the greatest importance from our forest point of view, and I shall attempt to describe my impression of how these rivers have more or less determined the present types of forest we find in the district.

It may justly be assumed that up in these giant mountain ranges, glaciers and land-slides on a small scale, due to excessive accumulation of snow, are of almost daily occurrence, whilst periodically they occur on a colossal scale, almost choking up the water-ways. Now when one of these slides takes place, a great volume of water is dammed up till the weight of the water breaks the dam, carrying it down in its career, overflowing down below and strewing the countryside with sand, boulders and *débris* of every description, while the subsiding waters usually dump large quantities of silt. When, as so often is the case, thousands of tons of coarse sand and boulders are deposited, this sand kills off all vegetation, even big trees, as may be witnessed even now in the drainage areas of the Digaru and Paya rivers.

Evidently in the course of time repeated floods wash away the sand or cover it over with clay or silt or humus, forming an eminently suitable seed-bed for such a species as *hollock*, whose winged seed is specially designed for being carried by wind long distances, and further aided by being water-borne. Water-borne seeds of other species

automatically come in, while stranded roots of climbers, etc., strike and throw out shoots to form new plants.

Hollock is specially favoured in these places, as it occupies most of the high lands and the lower hills, the seed is winged and specially adapted for flight, and there is a nightly prevalence of high winds down the river gorges. Again the seed matures and falls off the trees from January till March, so that it gets a chance of germinating and taking root before the rains come to wash it away, and then it has the full benefit of the monsoon, by the end of which it is practically established. The areas being free of weeds and climbers the plants develop rapidly and form the occasional fine stands of *hollock* we now see.

My first visit up the Lohit valley road was an object lesson in nature's seemingly wanton destruction. From the bed of the Digaru looking up to the hills one can see that the nose of a mountain range has slid into the drainage areas of the Paya and the Digaru rivers and it is this obstruction that is responsible for the thousands of tons of sand washed down by these rivers annually through the temporary damming up of the waters and their subsequent escape. At Tetsam near the former bed of the Paya river, as far as the eye can see, stretches for miles a sea of sand studded with the stag-headed remains of giant *hollock* and *khokan* trees whose trunks are getting annually buried deeper and deeper in the sand. But the death of the old forest had made way for the new—for I suddenly came upon an area of vast extent, with an even-aged crop of almost pure *hollock* of two to three feet in girth, and of luxuriant height growth, while the spacing was so even as to give the impression that it was planted. A most marked feature was the soil which was distinctly sandy and almost devoid of all undergrowth. The crop I reckon was not more than twenty years old.

Needless to say these two scenes created a great impression on me,—the former, regret at nature's wanton destruction; the latter an object lesson in nature's method of afforestation. The area had obviously in the recent past been part of a river bed; as the river

gradually changed its course the slower flow of water deposited silt from that held in suspension in the water. Water or wind-borne *hollock* seed germinated and having no weeds to contend with, the seedlings came through rapidly and established themselves.

The lower lying areas naturally have the water flowing over them for a longer time, and as the water continues to flow a great part of the sand gets washed out and as the water slackens its speed clay and silt is deposited. Sometimes so impervious is this coating that these places remain water-bound for a comparatively long period even when there is no flow of water. The conditions thus produced are ideal for such species as occur in our moist forests where their water loving qualities enable them to flourish in the midst of dense scrub and climbers. Most of these species such as *Dillenia indica*, *jarul*, *morhel*, etc., are found on the banks of streams and rivers, and as their fruit and seed are water-borne, they get stranded as the water dries up and germinate to form our low-lying hygrophytic type of forest.

The *hollong* forest on laterite soil, I think, is of much older formation, and is the result of upheavals or land-slides in the hills. With this type we are all no doubt very familiar, but nevertheless I shall record my observations. As we all know, our rivers are for ever changing their courses; the alterations in some cases are almost imperceptable, whilst in others we can daily watch the work of erosion going on and fresh banks forming lower down. The natural tendency of the river being to take the shortest journey, *i.e.*, to straighten itself out, the exact spot where erosion will take place depends on the deflection of the current, and the consistency of the bank on which it impinges.

As reclamation takes place it is very interesting to watch the advent of vegetation. The first comers are usually a dwarf species of *Ficus* and a *Salix* which stand long periods of submersion, and seem to flourish on almost pure sand and boulders. These generally grow in the river bed between the cold-weather water level and the ordinary rains level. These hold up floating *débris* which in its turn leads to

rapid silting up. Next we find *tamarisk* (*Tamarix dioica*) invading the area. The roots and branches of these plants give a foothold to the seed of coarse grasses such as *Saccharum* spp., which soon cover the area. These with their dense interlacing roots help to bind the soil together, and when the water rises it scours out irregular channels between the clumps of grasses often exposing the roots. It is in these channels that *simul* seeds carried by the water get held up, and as the water has cleared a small space the seed germinates, and being very fast growing comes through. *Sissoo* (*Dalbergia sissoo*) is introduced in the same manner, as also sometimes (as I have seen) a small *sissoo* plant gets cut out by erosion and deposited lower down, where it takes root, and if conditions are favourable and reclamation instead of erosion is taking place it grows to fructify and reproduce, thus accounting for the small patches of *sissoo* met with along the banks of the Lohit on land of obviously fairly recent formation. *Sissoo* and *Salix tetrasperma*, I have noticed, are capable of withstanding fairly long periods of inundation without any outward symptoms of ill effect, on the contrary, they seem to be all the better for it.

3. *Experimental work to encourage regeneration.*—My excuse for the above lengthy effusion must be that the basis of all our knowledge in forestry as well as most if not all of our sciences, is the intelligent and rational observation of natural phenomena, and the logical deductions drawn therefrom.

Having taken over charge of the Sadiya division in May 1926, I found that the Assam Saw Mills and Timber Company who have a 30-years' lease with the Assam Government, whereby they have a monopoly for working the forests of the Sadiya Frontier Tract on very favourable conditions, had been working since 1921. They had annually cut out about 10 to 12 lakhs of cubic feet to obtain about 6 to 8 lakhs of cubic feet of converted material, the annual requirements of the mills. Nearly all the accessible unclassed forests had been exhausted or nearly so, and the Poba reserve adjoining the veneer mill at Murkongselek had been exploited till the management considered it no longer a financially workable proposition.

The mills obtained permission to work the Pasighat protected forest in 1927 and from 1928 worked this area during the cold season and the Paya protected forest during the rainy season, owing to river floating conditions.

Realizing the vast scale on which *hollock* (*Terminalia myriocarpa*), the wood chiefly wanted by the mills and the sole wood used in the veneer mill at Murkongselek (which is bound to convert and pay for three lakhs of cubic feet per annum as a minimum under the agreement), was being cut out, it seemed necessary that something should be done to try and make reafforestation keep pace with exploitation. There existed at the time a planting scheme whereby we artificially sowed up with *hollock* 75 acres annually, at a cost of about Rs. 30/- to Rs. 40/- per acre for creation, exclusive of maintenance.

From the time of taking over charge of the division a considerable amount of time was spent in going very thoroughly through areas worked over by the company during the past six or seven years, with a view to finding out what if any natural regeneration had resulted from the fellings to replace the trees cut out. *Hollock* was practically the only species worked out during the last ten years from the Poba reserve for which a five-year felling scheme had been prepared and worked to since 1921, and the northern end of the Pasighat protected forest had been worked over about 1918-19. A careful examination showed that there was a total absence of regeneration of *hollock*, and that the clearances made by the fellings were densely covered by masses of weeds and shrubs. This afforded room for thought, especially as it was observed that in March and April all drag-paths and openings where the soil was exposed during current fellings were covered by millions of *hollock* seedlings. Frequent observations showed that where hundreds of seedlings had been noticed a few months before, weeds had come in and choked them off, leaving one or two thin weedy plants whose whole energy had been put forth to keep pace with the weeds, and obviously the struggle could have but one end.

In June-July 1928-29, as an experiment based on the above observations, 200 acres which had been worked over in 1926 to 1928 on both sides of the company's tram-line was weeded at a cost of

under Rs. 4/- per acre. Weeding was deliberately postponed till June-July as it was found that up till that time there was healthy competition going on between the *hollock* seedlings and the weeds, but further delay would have been fatal to the former. The main factor for success is in choosing the psychological moment for carrying out the weedings, which must synchronize with the point when competition between the *hollock* plants and the weeds ceases to be of benefit to the former, and having regard to the great light-demanding properties of *hollock* even slight delay makes all the difference between success and failure.

The result of the experiment was a great success, and showed that where the weedings had been delayed a year in the 1926-27 area, a few scattered *hollock*, *poma* (*Cedrela toona*), *bola* (*Morus laevigata*), *siling* (*Chikrassia tabularis*), and *khokan* (*Duabanga sonneratioides*) were found on the ground, but in the 1927-28 area dense groups and strips of *hollock*, with scattered *bola*, *poma*, *siling* and *khokan* were found all over the area representing about 40 per cent. stocking. In the second year a cleaning was carried out over the area, and in the third year the crop was practically established, being over twenty feet in hight, and needing only climber cutting and thinning out in places. The then Silviculturist and the Conservator of Forests were so enthusiastic over the results, that the then I. G. Forests, Sir Alexander Rodger, was invited to visit the area, and he too was satisfied with what he saw.

Our present working plan of the division is based on the results of this experiment. Unfortunately our enthusiasm led us to embark on an over-ambitious programme. In addition to attempting a colossal area in the Pasighat protected forest, we at the same time attempted a similar area in the Paya protected forest where labour was not available, nor the conditions were as favourable as in the Pasighat area. For the Paya forest we had to draw in labour from our Pasighat area, and transport them a three days' journey to Sanpura. The areas were too big to be efficiently controlled. The staff with a superhuman task before them did what they could, but the areas could not be gone over expeditiously, and the net result was very unsatisfactory.

Personally I think one big question presents itself with reference to our so-called evergreen forests, *viz.*, "*Do we want a small area fully stocked at great expense, or a large area with say 20 per cent. to 40 per cent. stocking, at a comparatively small cost?*" This question will have to be answered with our hands in our pockets, for our capacity for spending depends on the amount of money available for the purpose. In raising this question, I am probably disturbing a hornets' nest. Idealists will take one view, while children of nature another. And a discussion on this matter will no doubt be welcome to the Editor of our journal.

REVIEWS.

NURSERY AND PLANTATION NOTES FOR BENGAL, 1933.

BY C. K. HOMFRAY, BENGAL GOVERNMENT BRANCH PRESS, DARJEELING, 1933. Price Re. 1/-.

Most of us are familiar with the very useful little interleaved pamphlet of 36 pages which appeared under a similar title in 1926. With the passage of time, a great deal more information has been collected, so much more that the present revision occupies nearly four times as many pages, though the material is reproduced in similar compact manner. The first 18 pages deal with general subjects and a table of seed times with a diagram of a nursery bed with shades terminates the book, whilst the remainder, by far the greater part, is occupied by notes for individual species. These notes are presented in a standard form very convenient for reference. They are arranged in alphabetical order by species, and it is possible to turn up at once the available information on, say, the nursery treatment of *Cryptomeria japonica* or the planting methods recommended for *Michelia champaca*. The provision of interleaved blank pages gives the necessary hint to users that they can help in improving and adding to the notes, and that their co-operation is expected. As the number of species dealt with has risen from about 40 to about 70, it is evident that a large amount of new material has been incorporated. The most notable additions are the evergreens. *Anisoptera, Calophyllum, Dichopsis, Hopea, Taraktogenos,* and above all *Dipterocarpus*, concerning which extremely little has hitherto been published, and this feature alone gives the notes special importance for most of India. Careful perusal of the introductory sections is also recommended, as they are full of useful information, mostly based on wide experience and many trials over a period of years.

These notes are the outcome of a great deal of good work throughout the province and their compilation is no mean task. Bengal is to be congratulated on the great progress made in plantation work and on having such an excellent vade mecum on the subject.

H. G. C.

PROGRESS REPORT OF FOREST ADMINISTRATION IN ASSAM FOR THE YEAR 1932-33.

Assam is one of the few provinces where forest reservation is still in progress on any significant scale ; some 32 square miles were added during the year and settlement proceedings in respect of another 150 square miles were in various stages.

Despite the bad times, there was a good deal of activity in most varied directions in the province. Artificial regeneration makes continued progress to such an extent that the notorious obstinacy of natural regeneration with *sal*, and the impossibility owing to lack of funds of doing all one should in other forests, can reasonably be viewed as being compensated to a considerable extent. It may be noted in this connection that after a period of disfavour, teak planting has been renewed, and we think this step will prove justifiable provided it does not go too far. Existing plantations demonstrate that teak can grow well in some places, but there are many other places where it neither has flourished nor is likely to do so. Teak has a very bad habit of making a most promising start and then not living up to it.

Two "anti" measures have been pushed with vigour, against malaria and poachers respectively, and though the Conservator records that a good deal remains to be done, it is clear that the measures taken have been definitely productive of good results. Rhino horn is now legally forest produce wherever found, and that is going to strengthen the hands of the department in their attempts to preserve a fine animal which without effective protection is in danger of extermination within a matter of a decade or two. The detailing of an Assistant Conservator of Forests to the charge of anti-poaching operations is a good move.

The failure of the village forest idea may be noted; we are informed in para. 2 that the policy of forming them has been abandoned and those already created have been cancelled under Government orders. The instances must be very few indeed in India where village forests have proved practicable over any length of time in meeting village requirements without destruction of the forest.

A remark concerning the Goalpara tramway will catch the eye of those interested in such matters. "Coupes will be sold in future on the understanding that carting is abandoned as soon as the tramline has been relaid, and this should enable the tramway to show a cash profit instead of a loss" (para. 17). Doubtless fuller particulars would demonstrate that this is sound economics, but there have been not a few instances where money put into tramways would have given a better return if put into a good roadway system for carts instead.

The province is still just showing a surplus, though it is down to rupees one lakh as compared with rupees three lakhs last year, despite a further reduction of expenditure by rupees two lakhs.

Four different departmental heads during the one year must be a bit unusual, and must make continuity of policy somewhat difficult to ensure.

H. G. C.

ANNUAL PROGRESS REPORT ON FOREST ADMINISTRATION IN THE PRESIDENCY OF BENGAL FOR THE YEAR 1932-33.

We do not find a great deal to comment on in this report, but the Bengal Forest Department is to be commiserated with in having to report a further if relatively small fall in the financial surplus despite the most valiant efforts—we know from sources other than this report that even valiant is an inadequate word to express the "economies" to which they have submitted. From an average surplus for the quinquennium 1926-31, of Rs. 13,37,000, the figure dropped to Rs. 34,000 in 1931-32, and now to Rs. 2,905 in the year under review. The two circles deal with very different forests and conditions, the

southern circle being able to show a surplus of Rs. 1¼ lakhs to balance a corresponding deficit in the north. Expenditure was reduced by Rs. 1½ lakhs, nearly all on "works" and capital outlay, no further reduction on establishments being presumably possible. The result is particularly reflected in the falling off of plantation work and climber cutting, the plantation area completed in the year in the Northern Circle being only 1,659 acres against a prescribed minimum of 4,501 acres, whilst very little was done in the Southern Circle except in Chittagong Hill Tracts.

The report is illustrated by two sets of photographs of plantations in Sitapahar Range and of kutch manufacture.

H. G. C.

CORRESPONDENCE.

MEASUREMENTS OF A GIGANTIC *TITASAPA* TREE (*TALAUMA PHELLOCARPA*).

SIR,

I send below the measurement of one gigantic *titasapa* tree (*Talauma phellocarpa*) which was felled in the Unclassed State Forests under Diphu beat in Lumding range, Nowgong division, Assam, and as far as I know this tree will be a record as regards the outturn. I hope this will interest Forest Officers, especially those of Assam.

Species.—Talauma phellocarpa. Vern. names—*Titasapa* (Assamese). *Sundi* or *Sundi Sopa* (Bengali).

Girth measurement at 4½′ from ground level	.. 30′—3″.
Do. do. at ground level	.. 34′—8″.
Log outturn	.. 1,039·0 cft.
Sawn outturn	.. 774·3 cft.
Royalty at -/6/- per cft. ..	.. Rs. 290/4/-.

R. K. DASS,
Forest Ranger,
Lumding Range.

EXTRACTS.

GAME PRESERVATION IN BURMA AND PROPOSALS FOR IMPROVEMENT OF PROTECTIVE MEASURES.

New Sanctuaries required.—Most civilised countries have now recognised that no policy of wild life protection can hope to be a permanent success unless it is built on a foundation of secure sanctuaries. Inviolable sanctuaries must be constituted to ensure that a limited number of representatives of every species of an indigenous fauna are perpetuated for all time. In Burma there are at present five areas notified as sanctuaries covering a total area of approximately 400 square miles. This, considering the total area of the Province and the variety of its fauna, is quite inadequate and further areas will have to be notified in the near future if all species are to receive the protection they require. Of the existing sanctuaries, Pidaung and Shwe-u-daung should be raised to the status of National Parks ; Maymyo can never be much more than a Wild Bird Refuge and the Moscos Islands sanctuary is of very little value.

Two more sanctuaries are urgently required in Central Burma for *thamin* and these should, if possible, be so selected as to include *saing* and hog-deer as well. One of the areas chosen might be on the Katha-Shwebo District boundary and the other on the borders of Minbu and Thayetmyo. Both these sanctuaries should be constituted with a view to their being raised eventually to the status of National Parks. The adoption of the above proposals would result in Burma possessing six effective sanctuaries, four of which could be raised eventually to the status of National Parks ; every species of the indigenous larger fauna would be well provided for and the protection of wild life in the Province would be placed on a thoroughly sound foundation.

The formation of a Wild Life Protection Society.—Periodically for the last ten years the formation of an association or society as an unofficial centre for fostering public opinion in favour of the conservation of the local fauna has been considered. So far nothing has materialised and since the need for such a society is now greater than ever the sooner the matter is taken up seriously the better. Ignorance is perhaps the greatest enemy of Wild Life Protection. Ignorance regarding wild animals and birds, their identity, habits, food and utility is general ; and people do not care to protect that of which they know nothing.

A Provincial Wild Life Protection Society inaugurated by influential nature-lovers and sportsmen, and supported by educated members of all communities, could do an immense amount of good. Such a society working in collaboration with the Society for the Preservation of the Fauna of the Empire, the Bombay Natural History Society and the Royal Society for the Protection of Birds could, by widening knowledge, evoking sympathy and promoting interest in the local fauna, create and foster a healthy form of public opinion. The Society should aim at the creation of a public opinion that will demand and support amended legislation for the better protection of the fauna. It should endeavour to gain widespread support from Buddhist priests,

teachers, magistrates, property owners and agriculturists. It should organize educational efforts on the lines of lectures, publications, leaflets and answers to correspondents on questions of food, status, habits, legal protection, etc., of wild animals and birds. A Wild Life Protection Society organized and run as outlined above would give a great impetus to Wild Life Protection and the Province as a whole would benefit enormously from its achievements.

(*Annual Report on Game Preservation in Burma*, 1932-33).

AN IMPROVED METHOD OF SOFTENING HARD WOODY TISSUES IN HYDROFLUORIC ACID UNDER PRESSURE.

BY K. AHMAD CHOWDHURY, WOOD TECHNOLOGIST, FOREST RESEARCH INSTITUTE, DEHRA DUN.

In order to cut fairly thin sections of hard tropical timbers for microscopic examination, it is necessary, in the first stage, to soften the small blocks of wood with some chemical. Many laboratories use hydrofluoric acid for this purpose. The usual procedure is to immerse the blocks in acid in gutta-percha bottles and to seal the stoppers with wax. The blocks are then kept in that state for varying lengths of time depending on the hardness of the timber. With some experience, one can make a fair guess at the time that a certain timber is likely to take to soften. Most of the hard Indian timbers take about six to eight weeks, which is a long time, especially when one has to cut sections for urgent inquiries. During the last two years some experiments have been carried out on various timbers at the Forest Research Institute, Dehra Dun, with a view to shortening this time of softening. The results obtained have been very satisfactory. Timbers which formerly used to take six weeks to soften have been softened under pressure in a week's time, and those taking eight weeks or more have been softened in ten to fifteen days.

In the present work a cylinder[1] similar to that employed by J. E. Lodewick (A Shorter Celloidin Method, Science, ii, 60, 67-8, 1924), was used with some modifications to suit the experiments. These modifications were : (*a*) a pressure gauge attached to the main body of the cylinder in order to indicate the pressure and to detect leakage, if any, during the process of treatment, and (*b*) the lining of the inside of the cylinder with lead sheeting to guard against the corroding effect of hydrofluoric acid. This gave satisfactory results.

To get uniform action of the acid, the small blocks of wood were first boiled in water for a few hours, and as far as possible all air was driven out of them. The gutta-percha bottles, containing the blocks in acid, without stoppers, were then placed in the cylinder. Having made the cylinder air-tight, pressure was applied by an ordinary foot-pump. The experiments carried out during last two years have shown that the best results are obtained by applying a pressure of about 80 lb. per square inch. More than this tends to render the blocks brittle. It was also found that mode-

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[1] My thanks are due to Mr. R. D. Tandan, Mechanical Engineer, Forest Research Institute, Dehra Dun, who made these cylinders for me.

rately soft to moderately hard timbers can be softened in two ways: either by diluting the acid[1] and keeping the blocks under pressure for a week, or by treating them with undiluted acid under pressure for two to four days. The former method is always better, but the latter method has been used for urgent cases with fairly satisfactory results. Hard to very hard timbers usually give no trouble when treated with undiluted acid.

At the end of the softening period the bottles are taken out from the cylinder and the blocks are washed and stored in the usual way.

During the course of experiment, over 200 blocks of some 125 species have been softened in this way. The list below shows some of the species in question and the time taken to soften them :—

Name of timber species softened.	Strength of H. F. %	Number of days under pressure of 80 lb.
Large blocks (size 1″ × 1″ × 1″).		
1. *Cedrela toona*	40	3
2. *Buxus sempervirens*	,,	7
3. *Diospyros melanoxylon*	,,	7
4. *Hopea odorata*	,,	14
5. *Juglans regia*	,,	3
6. *Populus euphratica*	,,	3
7. *Santalum album*	,,	7
8. *Shorea obtusa*	,,	10
9. *Shorea robusta*	,,	10
10. *Terminalia tomentosa*	,,	8
Small blocks (size ¼″ × ¼″ × 1″).		
1. *Dipterocarpus costatus*	,,	7
2. *Dipterocarpus pilosus*	,,	7
3. *Hopea odorata*	,,	8
4. *Ougeinia dalbergioides*	,,	9
5. *Terminalia tomentosa*	,,	5

(*Annals of Botany, Vol. XLXIII, January* 1934.)

FORESTRY DECALOGUE.

1. Love and praise the forest which is God's handiworks, because it is the most precious gift He has given to humanity. Adore the trees.

2. Do not destroy the forest, because it fills many a human need from cradle to the coffin.

3. Sanctify bird and Arbor Day to impress upon the youth the love of and respect for the forest and the creatures that build their nests on the tree tops.

[1] Commercial hydrofluoric acid, 30—40 per cent.

4. Honour your country by respecting and conserving its forest. It is the yardstick by which is measured the degree of our civilisation.

5. Do not unlawfully destroy the fountain of wealth—the forest. Besides the revenue we get therefrom it conserves water, protects soil, and regulates climate, all for our comfort.

6. Do not voilate the Forest Laws which seek to conserve the forest in productive condition for the present and future generations.

7. Do not steal timber and other forest products nor the wild animals from the forest. Defraud not the people of the fund which forms one of the principal pillars of the schools.

8. Do not lie in any shape or form when making your invoices or other forestry manifests or game reports.

9. Do not prostitute forestry by adulterating forest conservation with land disposal. Let all your acts be beyond any shadow of doubt.

10. Do not covet privileges or rights lawfully obtained or granted nor illegally occupy or use the public forest or part thereof.

The ten commandments briefly comprehend:—

1. Use the forests and secure from them the greatest possible benefit and revenue for the greatest number.

2. Conserve the forests in the best condition for the present and future generations. (*The Makiling Echo, January* 1934).

QUALITY OF PLYWOOD.

A Structure of Reliability.

Mr. Percy A. Wells, well known because of his connection with the Shoreditch Technical Institute, from which he recently retired, delivered a lecture, in a series on furniture topics, at the Geffrye Museum, Kingsland Road, Shoreditch, London, E., on " Plywood: Its influence on design and construction."

The official report of recent excavations in Egypt, said Mr. Wells, described the discovery of a coffin made of six-ply cedarwood found in the tomb of a king buried in 3000 B.C., and they also knew that the famous cabinet-makers of the eighteenth century laminated their panels and their fretted rails and pediments, while walnut and veneers were introduced into furniture design in the seventeenth century. In his own experience of workshops of 40 years ago, it was customary to laminate thin mahogany for panels which were to be veneered.

For many years plywood was looked upon with suspicion and, when used, was put out of sight as much as possible; but experiment had brought this " manufactured timber " to a structure of reliability and strength rivalling the real wood. It is now a ready-to-hand material, of large dimensions, suitable not merely for the construction of furniture, but also for ceilings, panellings, dadoes, partitions, and all types

of wall covering. It was now possible to dovetail, tenon, tongue and groove laminated boards, and the thin plywood lent itself to rapid methods in wall-panelling.

The qualities and virtues of plywood over solid timber he classified as follows: It is stronger in the board; it bends without breaking; shrinks or warps are less; and it can be made and used in larger dimensions. These qualities of structure depended largely on method of production, quality of veneer, and care in pressing and drying. The advent of the laminated or blockboard produced the flat, straight and angular design now so prominent in modern furniture. When one considered the many articles now made of plywood, the change in design was stupendous. It was a change one had to accept, for the manufactured and laminated board had come to stay.

Design might become too bound by material and of losing its freedom and vigour. Boards had been flat previously, but because a laminated board was flat, straight and square, this was no sound reason why a wardrobe should look like an enlarged box. There was still ample scope for designers in the treatment of this revolutionary material.

Commenting on examples recently seen in London of all-ply Finnish furniture, Mr. Wells said it was ingenious and attractive, and presented remarkable possibilities in the use of plywood. He urged young students of furniture history to master traditional methods of construction and materials side by side with modern developments. (*Timber Trades Journal, 24th March* 1934).

SPIRAL STRUCTURE.

Spiral movement and development among organisms are expression of a wide spread tendency which is protoplasmic in origin. Twisted grain is not due to prevailing winds acting on a symetrical crown because there is no evidence within the tree trunk that actual twisting took place after the wood was formed.

Spiral habit is equally characteristic of animals from the lowest to the highest. The ultimate cause, if there is a universal one, must be protoplasmic in character. In mammals there is a pronounced tendency among body organs to show a marked right or left twist. The cardiac loop in man rotates dextrally. Bast fibres give evidence of special wrapping. Molecules are at a time subject to spiral habit. Plant chromosomes have spiral structure; chromosomes are carriers of a trait which they themselves possess.

Spiral grain in trees is due to the gliding growth of cambium cells with oblique transverse walls. This type of structure must be a contributing factor to spiral growth of trees. There is throughout nature a very marked tendency toward form and motion. There are several other forms of spiral structures in plants, the coiled thickenings of the walls of xylem vessles, the twist in bast and cotton fibres. It seems that the spiral habit whether in trees, snails or chromosomes, is a fundamental heritable protoplasmic quality. (Spiral Habits of Trees, Science, 20th October 1933). (*The Makiling Echo, January*, 1934).

WHERE TIMBER HOUSES SCORE.

More comfortable, drier and cheaper than brick—truth about fire risk—the use of B. C. Red Cedar.

It would have done the hearts of all interested in timber development good if they could have heard the lecture on "Timber Buildings," which Mr. I. J. O'Hea, director of W. H. Colt (London), Ltd., gave at the meeting of the British Wood Preserving Association in London on Wednesday evening. Full of striking points, it was illustrated by a remarkably good series of lantern slides showing timber buildings in many lands.

In Russia, Scandinavia and the North American Continent, said Mr. O'Hea, 80 per cent. of the living houses were built of timber. Timber construction for domestic buildings might be very roughly divided into three methods: the solid log type; the solid wall made up of a multiplicity of timber planks; and the frame building. Mr. O'Hea gave interesting details of these methods, and, speaking of Russia, said the specification for wall thickness for an ordinary brick house there was 28-in. The 8-in. thick log type timber wall afforded better insulation than the 28-in. brick wall there. There were log buildings in Russia 500 or 600 years old. Some of them were illustrated on the screen.

The log form of construction was found in Scandinavia in a very similar form to that in Russia, but the majority of the modern living houses there were built of machined timber in the form of boarding. Climatic conditions were, of course, intensely severe, necessitating the best possible insulation against cold, and timber was the first medium for ensuring this.

When the L.C.C. were developing their Becontree estate they imported experimentally 12 pre-cut Swedish houses. The L.C.C. admitted that these 12 houses were some of the few houses on that estate, alternative to brick construction, with which they had not had a single bit of trouble. Tenants were loud in their praises of the comfort both in winter and summer. The reason why the Council did not continue with this form of construction was that it would necessitate the importation of skilled Swedish builders, whose knowledge was essential for assembly.

Fire Risk Objection Answered.

Having dealt with the Canadian and American methods of construction, Mr. O'Hea said he would like to give what he thought was a complete answer to the principal objection levelled against timber houses—fire risk.

Some recent statistics disproved entirely the common belief that the fire risk in a timber house was greater than in one built of brick, concrete, or other incombustible material. It was practically impossible for a timber house to ignite from an external cause, and these statistics showed that the cause of fire in any type of building was almost invariably an internal one; that was to say the fire started in the contents, such as curtains, clothing, fuel, rubbish, etc.

In order to make any house fireproof it was necessary to have the contents fireproof. This, of course, was impossible. Some years ago the United States National

Board of Fire Underwriters made a survey of buildings in various American States. The survey covered 1,254,192 buildings; 75·3 per cent. of these were timber houses. There were 1·65 fires for each 100 timber houses, and 2·43 for each 100 brick and stone buildings.

"What is more interesting still," said the speaker, "is the following: It is commonly believed that timber houses are a source of danger to adjacent buildings owing to their assumed liability to catch fire. Of all fires 98·7 per cent. were confined to the building in which they originated, and bear in mind that three-quarters of all the buildings examined were timber buildings."

Lloyd's Insurance Rate.

Actually, a building composed of incombustible material was just like a furnace once a fire started in it, and, although there might be a little more salvageable material left at the end than compared with a fire in a timber house, he definitely stated that there was no greater risk of fire in a timber house than in a so-called incombustible house. This, he thought, was conclusively proved by the fact that timber houses built by his firm were insured at Lloyd's against fire at the same rate as brick houses, namely, 1s. 6d. per cent.

Dealing particularly with the timber building in Great Britain, the speaker spoke of the advantages of a well-built timber house. It was considerably more comfortable, he said, than a brick house, owing to the far better insulation afforded by the walls, both in summer and in winter. It was drier than a brick house, and in this connection it was interesting to note that they had had cases of clients coming to them, having been advised by their doctors to live in a timber building. "We have definite evidence from clients who have suffered from rheumatism and other like complaints, and who have been either entirely free or very much more free from it after they have moved into a timber house."

The speed of building was another point which frequently became of considerable value. Not only was the fabric of the building itself erected in a very much shorter time, but the building was complete and made habitable much more quickly, owing to the fact that there was no necessity for the walls to dry out, as in the case of brick.

Regarding the matter of comparative cost, a parallel and direct comparison definitely showed that a timber building was considerably cheaper than a brick building, the difference being somewhere in the neighbourhood of 25 per cent. Sometimes this saving was very much greater, sometimes less.

There was considerable prejudice against timber buildings, and although he was glad to say that this was gradually breaking down they had still a long way to go in this matter. The existence of that prejudice was one reason why the final cost of a timber house was not far lower than it was.

In recent years the speaker said they had extensively adopted the use of red cedar for weather boarding. British Columbian red cedar had the extraordinary property of

containing a natural preservative within itself, and required no treatment whatever. It was a most attractive wood in appearance.

In discussing timber buildings, he could not omit to mention the extremely interesting roofing material which his firm standardised on most of their buildings, namely, British Columbian red cedar shingles. These were wood tiles made from red cedar, requiring no preservative treatment whatever, and forming a highly satisfactory roof. Coloured preservatives might be applied to them in order to obtain colour effect. Red cedar shingles or tiles were more or less the standard form of roofing in Canada and the western United States. As a roofing material they compared extremely favourably with the clay tiles in weatherproofness, durability, appearance and cost. This was rather a startling statement to make, but nevertheless it could be substantiated. The cedar wood tile was less pervious to moisture than a clay tile. It made a completely watertight roof, with less chance of leakage than with a tiled roof. It afforded better insulation. It was more economical, and its life was 60 years. The use of British Columbian cedar wood tiles in this country was increasing considerably.

A valuable contributor to the discussion that followed the lecture was Mr. J. Waldron, an architect, who spoke most convincingly, and from rich practical experience of the virtues of timber—" the finest building material we have in this country, " he described it. This speaker mentioned his own experiences in connection with a large number of timber houses and a large number of brick houses at Woolwich to accommodate workers. The repairs to the brick-built houses worked out at £3 8s. per annum per house. The cost in connection with the timber houses, including re-creosoting—and also, by the way, making up roads—only came to 30s. per annum per house.

An interesting point mentioned was that while there were cases of tuberculosis in the brick-built houses, not a single case was reported in a timber-built house, and the local doctors took timber houses for themselves if they could get them. For comfort, convenience and health—and especially for dryness— the timber house was a great success, said Mr. Waldron. He had never found one instance of dry rot on any of the timber housing estates which had been under his care.

On economy, Mr. Waldron gave details of a place he had built of timber, comprising a studio 24 feet by 15 feet, bedrooms, the usual offices and so forth, with electric light, and every convenience, the total cost of which was £600, and which could not be repeated in brick at under £ 1,000. Dealing with the question of by-laws, he mentioned cases where local surveyors had endeavoured to uphold by-laws which were really obsolete, and under powers of the Ministry of Health the erection of certain houses which had been objected to was eventually authorised.

Colonel Newcombe spoke of the slum clearance schemes, and suggested that they offered a great opportunity for the fuller utilisation of wood for dwellings.

Mr. W. A. Robertson, Director of Forest Products Research, presided.

(*Timber Trades Journal*, 17*th March* 1934).

WOOD FOR 'PLANES.

METHODS BY WHICH THE WINGS ARE BUILT UP.

By K. G. Fensom (Managing Director, Canadian Hardwood Bureau).

Of interest to the timber trade is the fact that, after intensive engineering research and in spite of all the improvements which have been incorporated in the metal wing, the wooden wing is still held superior by many aeroplane manufacturers, who maintain that it possesses greater resiliency than the metal wing for a given strength. Actual tensile tests have proved that the wooden wing in flight is capable of absorbing with ease many strains which are exceedingly damaging to the metal wing; also the transmission of vibration and motor sounds is augmented in the case of metal wings.

The manufacture of these wooden wings requires the attention of skilled workmen. There is a good deal of talk at the moment about the necessity of strengthening the British Air Force. Any planned programme of aeroplane building would certainly yield activity to U. K. woodworkers.

Though wood is employed in various parts of the machine, its chief use is in the wings, which are built up as follows: A skeleton is constructed of two longitudinal spars, which are joined together by equally spaced ribs running from the leading edge to the trailing edge of the wing. The section of the aerofoil is always greatest at the front spar because most of the lift occurs near the leading edge. The curvature of the spacing strips is carefully worked out by the designer, and it is the degree of this curvature which determines the lifting properties of the wings.

The ribs are built up of strips of wood about 1 in. wide and ¼ in. thick. These are placed at the top and bottom of the curved central rib member—of plywood. The front ends of these strips are connected to a small moulding or leading edge spar that is termed the "nose" of the wing. The various ribs are tied together by light round wooden rods, which extend from one end of the wing to the other.

Another method of construction is the built-up web. All portions of the wing structure are glued and screwed together. Thus, although there are many individual pieces, the methods used for joining them together are so secure that the completed structure has great strength for its weight. Usually a textile fabric is stretched tightly over the wing frame and is fastened to both upper and lower surfaces of the ribs and spars.

A thin veneer of wood is often used to give the leading edge a positive curvature. Sometimes plywood is employed as the wing covering instead of fabric. Stiffening of the wing is accomplished through wire bracing, and by means of tie wires joining the front and rear spars.

Eith r Canadian spruce or American ash makes admirable wing spars; while the ribs arr usually made of poplar, spruce, or mahogany. Spars are either built up, or are made in one piece. The central rib member is often made of plywood, with various forms of cut-outs to lighten the structure.

An interesting development in the aircraft industry is the completely built-up wooden fusilage, in which some manufacturers specialise. Sir Hubert Wilkins, when he flew over the Arctic, used a 'plane of this kind, and states that he prefers this type for his most dangerous work. In the manufacture of wooden fusilages there is thus opened up a comparatively large field for wood utilisation, and those merchandising timber should press home its advantages for this use.

(*Timber Trade's Journal*, *17th March* 1934.)

INDIAN FORESTER

JULY, 1934.

HYDROGEN ION CONCENTRATION IN FOREST SOILS.

In the *Journal of Forestry* for April, S. A. Wilde of the Wisconsin Conservation Department has an excellent article on the Hydrogen ion concentration in the soil, what it means and how the figure obtained is of use in practical forestry. Pure water contains equal numbers of concentrations of H and OH ions and hence is neutral. When an acid is dissolved in water it gives rise to H—ions but not to OH—ions and so there results a greater concentration of H—ions than OH—ions and the solution becomes acid. The greater the concentration of H—ions the more acid becomes the soil. Similarly when an alkali is added to water the concentration of OH—ions becomes greater than H—ions and the solution is alkaline. The symbol pH about which we have been hearing so much lately was devised by Soresen and is simply the logarithm of the reciprocal of the H—ion concentration. To take Wilde's example suppose the H—ion concentration of a solution is 1/1,000 gram per litre what is the pH of this solution ? The reciprocal of 1/1,000 is 1000. The logarithm of 1,000 is 3. Hence the pH of this solution is 3. The pH for water is 7, hence a pH of 7 designates neutrality. Values under 7 become more and more acid and values over 7 become more and more alkaline.

To come now to questions of practical forestry. It is quite easy to determine figures for typical sal soils and for soils where sal is regenerating naturally. We can then apply those figures to problems of artificial reproduction so that sal is only planted on soils with a suitable pH number. This is a matter of very great interest to Bengal. The failure of sissoo in the Khanewal plantation of the Punjab was

discovered by the investigation of the pH values of the soil to be due to excessive alkalinity. We now can investigate the soil of any compartment to be planted and determine whether it is suitable for sissoo or farash (*Tamarisc articulata*).

Sind is considering the establishment of irrigated plantations and before money is spent on afforestation we would strongly advocate the investigation of the pH values of the soil.

Such an investigation is of the utmost importance where natural regeneration has for unknown reasons become difficult and may give a decisive answer to the question.

In America soils of a pH 4·5 to 5·5 are well adapted to the majority of conifers, whereas the best broad-leaved forest is found on soils of a pH 5·5 to 6·9. The unfavourable influence of alkaline soils upon most forest trees is due either to toxicity of OH—ions which are considerably more injurious than H—ions or to the excess of calcium or magnesium carbonates, causing a lack of available iron (chlorosis), a general disturbance in the assimilation of other nutrients and often fungus disease. The herbaceous flora may often be correlated with the pH value of the soil and this is an investigation which the Forest Research Institute is now taking up. We know far too little about our forest soils and it is quite time that this matter received the attention of the provincial research officers. Efficient pocket testers are available giving results within 0·5 pH which is adequate for forestry practice, and a lecture and demonstration is being arranged for the next meeting of provincial silviculturists.

CUPRESSUS CASHMERIANA

By C. G. Trevor, C.I.E., I. G. Forests.

A cypress sent from Kalimpong in Bengal has been identified at the Forest Research Institute as *C. cashmeriana*. This species is accepted as a distinct species by Dallimore and Jackson in the Handbook of Coniferæ and by Camus in "Les Cypres." In the Trees of

Great Britain and Ireland the tree is ascribed to Royle and to Cashmir by Carriére, apparently without any good reason for doing so—Royle himself makes no mention of such a cypress.

The only cypress native to the Western Himalaya is the well-known *C. torulosa*, and *C. funebris* is a cultivated tree in all hill stations reaching its best development in Darjeeling. It is extensively planted in Sikkim and Bhutan and is said to be wild in China. *Cupressus cashmeriana* is not known in the wild state and Hooker apparently did not distinguish it from *C. funebris*. *C. torulosa* we know and *C. funebris* we know, but what is this *C. cashmeriana* ? Is it anything more than a garden variety ?

THE TIMBER TRADE IN THE UNITED KINGDOM

By E. A. Garland, I.F.S.

It has been estimated that in normal times the timber trade in the United Kingdom deals with annual imports of hardwoods alone, which are in the neighbourhood of 1,000,000 tons, and that the total value of this market may be about 13 million pounds sterling. Of this, some 10 million pounds are for manufactured timber and about 3 million pounds for manufactured goods. To examine in any detail the vast ramifications of a trade of these dimensions in the short space of one month, during which I was placed on deputation in England by the Bombay Government, was obviously not possible. Indeed it was only through the kindness of the Timber Adviser to the High Commissioner for India, Sir Hugh Watson, in giving me every sort of assistance and information, that I was able to glean some impressions, which may be of general interest.

The English timber trade is intensely conservative. There is a general reluctance to deal in any timbers which are not well-known, and which have not proved their worth by long usage. This innate conservatism, however, has been broken down to some extent in recent years by the general trend of public demand for cheap first cost, irrespective of lasting value, and by a genuine desire to " buy

British." But unless a timber is cheap, available in regular supplies, prompt to order and well up to specification, it has no chance on the market.

Mass production has superseded craftmanship since the War. Cheapness is the first essential requirement. Timbers of course are roughly grouped according to the class of work for which they are required, veneers, panelling, furniture of different grades, high-class or cheap construction work, or small fittings. But in each group, cost is a ruling factor. While there is generally some demand for hardwoods of the very highest class, particularly if they possess well-marked figure or unusual colour, for special decorative purposes at good prices, this market is capricious and largely dependant upon " fashion ", which may change rapidly and apparently unaccountably. Even in construction work, individual designers or architects may take a fancy to one timber rather than another. For instance, where one Railway uses *gurjan*, another uses *jarrah* for exactly the same class of work. Matters such as this, except through the effect of advertising, are beyond the control of the producer.

It is here, as well as in other ways, that the services of a recognised broker may be of great value. The broker looks after the interests of the producer in many ways, advises him as to the trend of the market, changes in prices or in fashion, puts him in the way of business and provides an insurance for the smooth conduct of contracts, which is almost inevitable for any overseas producer, separated by thousands of miles from his customers. In the event of any dispute arising as to whether a consignment is up to specification, the broker acts as arbitrator. It is also a valuable point in any broker's contract that, though an order may cover several separate shipments, each shipment is treated as an entity and is paid for as such. Any failure in one shipment to comply with specification will not invalidate the whole contract, nor form grounds for cancellation of further consignments on the original order. The broker also acts as guarantor for the financial stability of the merchant, from whom he has received the order, and himself makes the actual payment.

The principal requirement on the hardwood market is for a cheap timber of general utility. This has been met in the past largely by the Baltic and America. But to anyone who has not previously seen them, the enormous hewn squares coming from Africa will be a source of wonder, particularly when he learns that such sizes can be put on the market at prices as low as 3 shillings per cubic foot, c. i. f. London. Even a cursory inspection of any of the principal timber yards in London will open the eyes of any producer to the terrific competition, which he must meet if he wishes to obtain any foothold on the market in the United Kingdom. Timbers in the greatest variety, apparently from every part of the world, are available at astoundingly low prices.

Although the usual purposes, for which timber is required, do not necessitate large sizes, these are nearly always asked for. Dimensions are always specified in any inquiry and for logs will probably be 84 inches and up, mid-girth, with lengths from 8 feet up, and an average of 16 feet. The slump in all trades and the general uncertainties of future trading conditions, have forced upon all timber merchants a hand-to-mouth policy. Stocks have been reduced and are only replenished against definite orders. Hence the importance of prompt replies to inquiries and early delivery on order. Competition for business is so keen that a merchant will probably give preference to a less suitable wood, rather than to a timber ideal for his purpose, if the latter is either slightly dearer, or if there is any uncertainty as regards continued supply. Also owing to the difficulty of obtaining any business, in all branches of the trade, there has been a steady tendency increasingly to pamper the purchaser, and to throw the risks and uncertainties more and more back on to the producer. For example, formerly most imports of teak were made in squares and flitches. Gradually more and more sawn timber was supplied and now this comprises nearly the entire trade in teak in a vast variation of sizes to suit every individual requirement. It is also now practically impossible to do any business on an f. o. b. basis. The trouble of arranging freight and insurance must be undertaken by the producer and quotations must invariably be made c. i. f.

The general position of Indian timbers on the markets of the United Kingdom may be summarised as one in which their cost usually prohibits them from competition in the ordinary group of common construction timbers. They can be used only for high class constructional or decorative work, for which good size and prime quality are essentials. Even in the high class group Indian timbers, apart from teak, occupy a small place. The imports of hardwoods from India (including Burma) in tons of 50 cubic feet for the past six years are stated by the Board of Trade to have been :—

Year.	*Teak.*	*Other hardwoods.*
1927	31,769	2,332
1928	36,633	3,412
1929	35,793	3,873
1930	32,213	2,541
1931	17,391	2,178
1932	14,621	2,276

Teak is the principal import and for this Burma holds the field. It is in demand for all high-class work and probably its uses could be extended considerably if its price was more competitive. During the years immediately following the War, the price of teak was kept very high and cheaper substitutes, such as *jarrah*, *gurjun* and Borneo *sarraya* got a footing. Their use continues even though the price of teak has dropped very considerably. *Pyinkado* (*Xylia dolabriformis*) from Burma has come in as a flooring timber and padauk (*Pterocarpus* spp.) for fittings. *Gurjun* (*Dipterocarpus* spp.) was originally imported largely as flooring strips, but latterly imports have been chiefly in the form of scantlings. Its market is fairly well established but competition is keen as the timber is available from Assam and Burma, as also similar timbers *yang* from Siam, and *apitong* from the Philippine Islands. Any other structural timber from India has to compete, not only with these but also against West African mahoganies which yield easily worked timbers and can be landed in England at very competitive prices. The market for decorative timbers is limited. Rosewood (*Dalbergia latifolia*) has held its own for many years but the demand has varied, and has never been heavy. Indian laurel

(*Terminalia tomentosa*) has only been recently introduced and is far from established.

The scope for development of trade from India therefore seems to be limited to the better marketing of timbers suitable for veneers, panelling, furniture and high class construction work, with a possible gradual extension towards timbers suitable for cheaper construction, fittings, etc., if improvement in marketing and especially through reduction of cost c. i. f. London, enables them to become competitive. Extended trade, however, can only be built up gradually on a sound basis of steady, satisfactory completion of small contracts. For timbers suitable for mass production purposes, quoted prices must be stable, apart from exchange fluctuations and similar causes which cannot be foreseen, so as to enable purchasing firms to work out costs of production for finished articles, which will be reasonably reliable. If policy suggests that specially low prices should be quoted so as to bring an unknown timber on to the market, it should be clearly stated that such prices represent a specified percentage reduction on the normal figures at which that timber can be supplied. Unfortunately, there is a distinct tendency among the trade in the United Kingdom, possibly based on somewhat regrettable experiences in the past, to consider that though Indian timbers may be excellent, there is such uncertainty of supply and delay in replying to definite inquiries, as well as a tendency not to comply fully to specification, that satisfactory business cannot be effected. Any attempt to send timbers "on consignment," *i.e.*, other than in fulfilment of definite orders, in the hope that they might find a satisfactory market on arrival, would be bound to fail, at any rate under existing trade conditions.

A NEW METHOD OF PILING RAILWAY SLEEPERS

L. N. Seaman, Officer in Charge, Timber Testing Section.

One serious cause of loss in wooden railway sleepers is *splitting*. Large numbers are rendered worthless for this reason before they reach the Depot. Others split fatally in the Depot, and still others split in the line. The prevalence and extent of splitting have caused

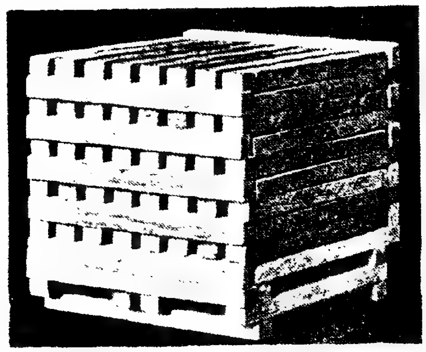
so much alarm that passing officers have, in some cases, been led to exaggerate the importance of small splits, and undue rejections have resulted. But drastic specifications and over-rigorous passing have not improved the situation. The remedy is to be found, not in rejecting otherwise good sleepers because they contain small and harmless splits, but by removing, or, if that is impossible, by reducing the cause of the damage, which can be accomplished by improving the seasoning conditions to which the sleepers are subjected after felling and conversion.

The difficulty of splitting, in a less acute degree, has also been experienced on American Railways, and an improved method of piling the green sleepers has been found to effect a saving. The object of the modified piling is to reduce splitting by retarding evaporation at the ends of the sleepers and securing a more uniform rate of drying at ends and middles. This is accomplished by so arranging the pile that each sleeper end is either butted against the side of another sleeper, or else it lies between two other sleepers, which project beyond it and afford it protection and shade. Figures 1 and 2 of plate 35 illustrate this arrangement, and also show why it cannot be applied in exactly the same way to Indian sleepers. The sleepers represented in these Figures are the standard 7″ x 9″ or 6″ x 8″ sleepers. With these, by placing the "cross sleepers" in the pile on edge, and then by butting one tier of sleepers against them and placing the next tier on top of them an air space of 2″ is left. These "cross sleepers" can also safely be placed so that their outer faces extend beyond the ends of the tier on which they rest.

With Indian sleepers 5″ x 10″, especially with the rather rough hewn sleepers that are frequently encountered, this cannot be done with safety, as the pile would be unstable. Nevertheless, this special piling suggests a new piling for Indian sleepers which may be expected to reduce loss from splitting, and which, at any rate, is thought to be worth trying.

This new piling is illustrated in Figures No. 3 plate 36 and No. 4. plate 35. The rate of drying can be controlled to a certain extent by altering the number of sleepers in the tiers, though the

FIG. 1.



Russell improved tie piling system.

FIG. 2

"RUSSELL IMPROVED TIE PILING"

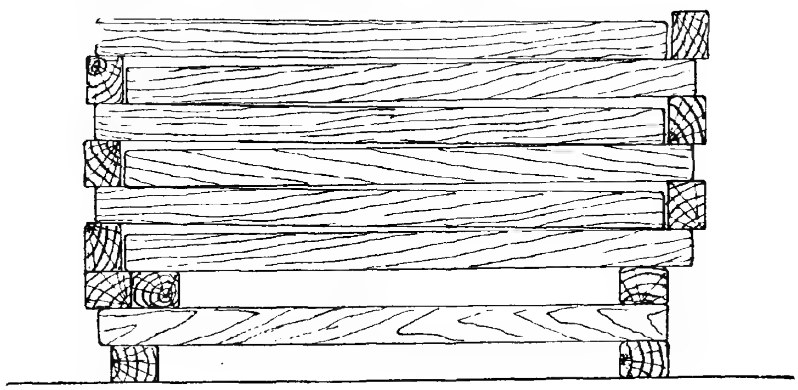
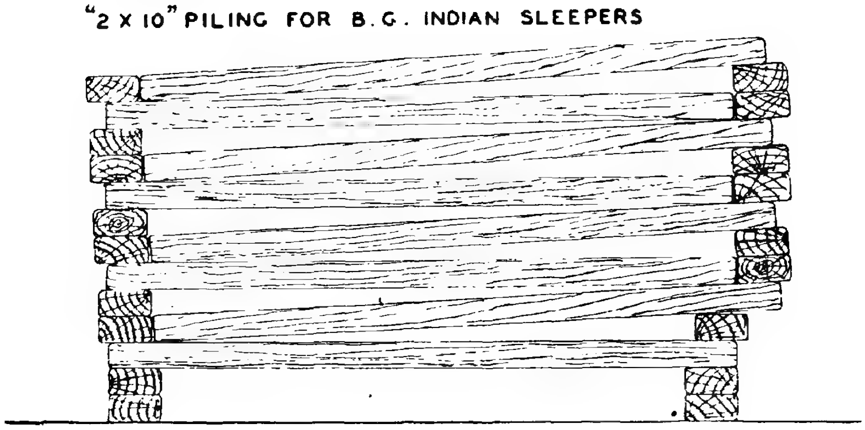


FIG. 4

"2 X 10" PILING FOR B.G. INDIAN SLEEPERS



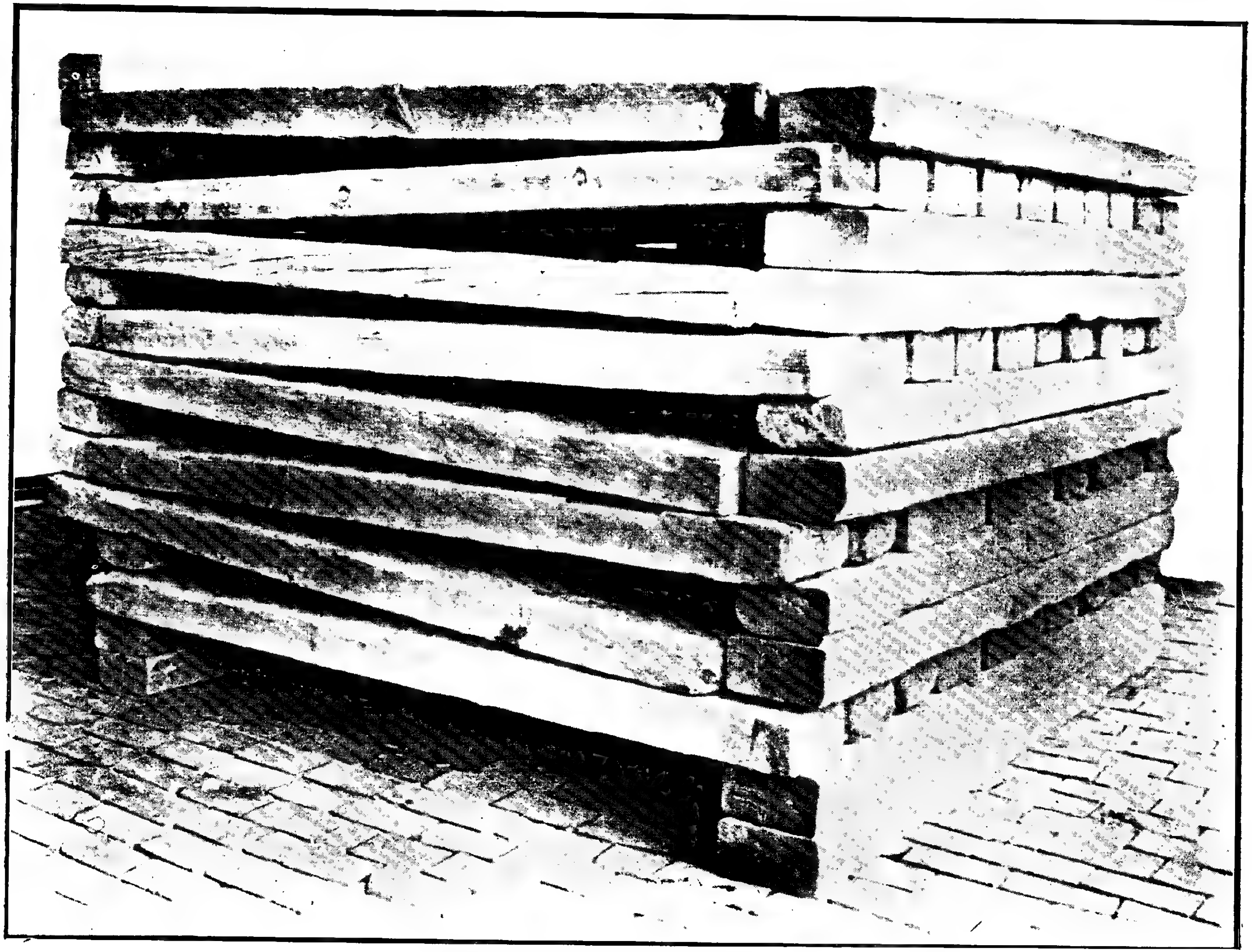


Fig. 3. New Stacking, "2 × 10" Method.

spacing will probably not be too close in dry climates if there are ten sleepers, evenly spaced, in each tier. The openings between tiers are wider than in the American piles, (5″ instead of 2″), but this cannot be avoided with sleepers of this shape. Shade for the piles is desirable, and if material be available without cost, say old sleepers, or sleepers already seasoned, the top tier might advantageously form a " roof " to the pile, but it is, of course, useless to suggest devices which would increase costs.

This kind of piling has not yet been tried out, but it may be expected to afford some improvement. The ends of the sleepers are undoubtedly better protected than in any former type of piling employed. It will cost no more to pile by this than by former methods and if good results are not obtained there will at least be no expenditure and no harm will be done. As mentioned above, this 2″ x 10″ method of piling is thought to be worth a trial by those who are experiencing trouble from splitting in sleepers.

RAT DAMAGE IN NORTH WEST FRONTIER PROVINCE FORESTS.

The following extract is printed from the Annual Report of the N. W. F. P. for 1932-33 :—

"Rat damage remained serious particularly near Thandiani and it can almost certainly be said that the few silver fir standards still seen in Chattri compartment 3 (*i*) and 4 (*i*) will be destroyed within a decade. The year's experience has not only confirmed the view expressed in last year's report that artificial restocking of these rat infected areas with conifers will be extremely difficult, but has also shown that unprotected broad leaved species may also suffer badly from rat attack. Deodar saplings over 10 years old are being girdled, while roots of young walnut plants unprotected by wire mesh netting cylinders have been seen destroyed by rats. They have not confined their ravages to trees and young plants but have extended them to seed as well. Excellent nurseries have been made barren by the rats by scouring the seed beds along drills and eating the seed. It has, therefore, become imperative to study ways and means of destroying

these rats in addition to protection of plants if afforestation is to succeed at all.

The following methods of combating rat attacks have been adopted with success :—

(a) In nurseries.

(1) Wire netting buried in the ground around the nursery 1½ feet deep and turned outwards at the bottom.

(2) Thorough gassing with Cyanogas on formation of the nursery, before snowfall and when any burrows are detected.

NOTE.—These methods have afforded complete immunity from rat attack in nurseries.

(b) In the forest for production of seedlings and transplants.

(1) Sowing of seed such as walnut in wire mesh tubes 1′ 9″ long buried in the soil turned outwards at the bottom and projecting 3″ above the surface.

(2) Sowing of seed in thick paper tubes 1′9″ long well soaked for at least 24 hours in cheap kerosene and buried in the ground and projecting 3″ above the surface.

The above two methods have been adopted with complete success so far and have been extended to transplants with equal success. The cost of the first method is, however, very heavy and it is hoped that the paper tubes will be effective. It is found that the rats do not usually burrow deeper than 1½ feet. The paper tubes have remained in good condition for 12 months and it remains to be seen whether they will remain efficient, preserving the smell, for a further year after which the plants should be more or less safe.

(c) Before planting out an area it is thoroughly gassed and a further application of Cyanogas is made before snowfall as it is observed that most damage is done under the snow on the surface of the soil. It has been noticed since the expiry of the period for which this report is written that these operations combined with the increase of undergrowth in the compartments concerned have reduced the number of rat burrows and it is hoped the pest will be overcome in the course of the next few years."

Note by Forest Entomologist.

The rats referred to are presumably voles, *Microtus brachelix*, at least the only specimen identified from Hazara is of that species. which is a matter of more than academic interest. In most countries where it is necessary to use control measures for voles, reliance is placed on poisoning with flour, crushed grain, or chopped hay baits, coupled with reduction of the natural food-supply by clean weeding and isolation by trenches or more effective barriers. The poisons ordinarily used are strychnine sulphate or s. hydrochloride and barium carbonate. In India they are recommended for use against mole-rats, field rats and field mice damaging crops, as well as against house rats and plague rats. Against mole rats in Sind strychnine hydrochloride was found to be effective while the results with barium carbonate and white arsenic were extremely poor. In sugar-cane plantations of Hawaii such marked success followed the use of strychnine wheat and barium carbonate cakes against field rats that an elaborate technique has been developed and established as a regular routine.

Poison baiting, however, depends for its success on a knowledge of the feeding habits and other activities of the rodent which can ensure that baits are taken. Incorrectly applied thousands of baits may be used without killing a single animal.

Fumigation has been used extensively in India and of the possible fumigants calcium cyanide dust (cyanogas) is not only the cheapest but is more simple to apply. The expenditure on material and labour when dealing with field-crops should not exceed one rupee per acre against two or three rupees per acre for a fumigant like carbon bisulphide.

The Thandiani method of using protective sheaths of wire gauze or oiled paper is sound in that it prevents the access of the voles to the plants. It would be worth while substituting furnace oil for cheap kerosene as this is a less volatile substance, has a strong deterrent smell and costs less. It is obtainable from the Burmah-Shell Oil Storage and Distributing Co., Ltd., and costs about Rs. 50 per ton ex Bombay. Anglo-Persian Oil Co.'s Heavy Diesel Oil at Rs. 55 per ton

packed in steel casks or drums may be used if supplies are taken from Karachi.

It would probably be an improvement to substitute poison baiting for the second fumigation with Cyanogas before snow fall on a planted area as a more effective way of dealing with invasion during the winter.

C. F. C. B.

TOUR JOTTINGS FROM SOUTH BENGAL

By H. G. Champion, I. F. S., Silviculturist, Dehra Dun.

In the course of a six weeks' tour made last November and December in the forests of the Chittagong Collectorate and Hill Tracts, I saw so many things of interest that I feel some extracts from my notes should be worth broadcasting to forest officers in other parts of India through the medium of the pages of the *Indian Forester*. In view of the disturbed conditions which have been prevalent around Chittagong of late, it would not have been surprising had forestry stagnated completely, but instead of this, it may be asserted that thanks to the efforts of several keen divisional officers and the Bengal Silviculturist and their staffs, very real progress of widespread significance has been effected in the last decade, more particularly in the last five years.

It would appear that the local officers are a bit shy of showing their work to visitors—it must be shyness, as they are too polite to be personal and the work is so well worth seeing. Any way, the Divisional Forest Officer left by air mail the very day I arrived, and the Conservator escaped the latter half of the tour by taking refuge in hospital. These same retiring habits have also presumably led to the forwarding to me of a request from the Editor for an account of the work done on the artificial regeneration of *garjan* (*Dipterocarpus* spp.) and other evergreens, a request I hope to be able to meet in a separate article.

The tour consisted in a run up the Kornafuli River by launch to that well-known plantation centre, Kaptai, which goes back to 1872, and then on by launch and country boat some 50 miles further up to

Virgin evergreen forest with large *Dipterocarpus pilosus* and *Buchanania lanceofolia* (buttressed), and evergreen undergrowth.

Mainimukh, Chittagong Hill Tracts.

Mainimukh, a rest house at the junction of the Maini and Kasalong rivers, important waterways for the many and rather picturesque bamboo rafts. Returning to Chittagong, we went round by steamer to Cox's Bazaar and by elephant and bicycle to Bhimoriaghona, which is the chief research centre in those parts. A pleasant bicycle ride southwards along the beach from Cox's Bazaar brought us down to Inoni to see bamboo experiments. A third expedition was made to Hazarikhel north of Chittagong with most interesting plantations and other work, appropriately finishing with a visit to Sitakund, a famous place of pilgrimage. On several occasions, I was afraid of losing my third companion from apoplexy or imprisonment for assault, as when all the boatmen noisily cleared their throats in the grey dawn, and when an unskilled mahout mismanaged his elephant, nearly throwing us with all our *impedimenta* into several feet of soft tidal mud and getting the poor beast deeply mired—but fortunately, he survived these shocks.

We were paying special attention to the natural forest types of the district, and as is so generally the case, came to the conclusion that " natural " forest, not significantly altered by human activities, is far from common even in these relatively remote and well-wooded tracts. At Mainimukh, we saw what could be accepted as genuine virgin forest (Plate 37), and there were remnants of it elsewhere, but by far the greater part appeared to have been subjected at some time or other, in greater or less degree, to interference by axe or fire or both.

This is not the place to go into details of the forest types distinguished, but two, which are known to extend down into Arakan and to have their counterparts in other provinces, may be mentioned with the object of directing the attention of forest officers with eyes and a critical faculty to working out and recording their probable origin. One of these is the more or less pure *garjan* forest, not the groups of *Dipterocarpus pilosus* which seem to be a natural constituent of the typical mixed evergreen, but the more extensive patches of *D. costatus* and *D. turbinatus*. They appear residual on the extermination of their associates, but are they really so and what are the special properties that ensure their survival when one might rather have

expected their selective destruction as good straight poles of better than average utility ?

The other type is the bamboo brake, mainly of *Melocanna* and *Bambusa tulda* with a thin deciduous overwood of *Albizzia*, *Bombax*, *Hymenodictyon*, etc., and an occasional *Dipterocarpus*. At first sight from the high adequately distributed rainfall, the fairly average soil, and general appearances, one might conclude that one has to deal simply with old hill *taungya* and this may be correct, but much of the ground looks too steep and broken for cultivation and various commentators have found difficulty in accepting this explanation. A wide knowledge of the country, including the parts where shifting cultivation is still practised on various cycles, is needed for reaching a well-based solution, and we wish someone would take it up.

Despite our confessed shortcomings and occasional lapses in the matter, we foresters in India can claim to remember that tenet of our profession which insists that there shall be no extensive fellings without regeneration. When we ignore it, conscience smites and we strive to mend our ways and remedy the damage already done. This of course applies above all to our tropical evergreen forests in which, despite local successes (unfortunately often *very* local) natural regeneration is usually most disappointing. In South Bengal, an instructive series of experiments is in progress (Mainimukh) which have already given valuable indications as to what is most likely to be the best line, *viz.*, the gradual opening up of the canopy from the ground upwards, leaving the top canopy intact till last. Light and space introduced in this way seem to benefit tree seedlings and saplings without over-stimulating weed growth which is the inevitable consequence of breaking the top canopy to any extent, or of being in too much of a hurry in any way. For success, the regeneration must be there already (how common is this experience from the top of the Himalayan forest to the mangrove swamp or the semi-desert thorn scrub !), but fortunately at Mainimukh, it generally is there. The comparable finding in the Andamans as described in Mr. Chengappa's recent valuable articles goes to indicate that the underlying principle is of general application to this type of forest.

Mistrusting entire reliance on natural regeneration, and emboldened by their experience and success under a wide range of conditions, the Bengal foresters simultaneously set to work to see why the commercially valuable species of the evergreen should not be raised in plantations, with due regard to probable special characteristics connected with the conditions with which natural regeneration has to cope, notably considerable shade and still moist air in the early stages. Success has attended their efforts, our old friend *Tephrosia candida* proving a great help particularly in minimising the exposure of the soil after clear felling. A separate account of this work will be published, so it will suffice to mention here that from a very small eginning as long ago as 1922, a " technique has been evolved " (a delightfully irritating expression !) by which successful plantations of *Dipterocarpus turbinatus* can be more or less guaranteed, whilst considerable progress has also been made for *Artocarpus chaplasha, Dichopsis polyantha* and *Hopea odorata*, whilst excellent beginings have been made with others such as *Eugenia* spp., *Calophyllum polyanthum, Lophopetalum fimbriatum, Taraktogenos*, etc.

Apart from the straight plantation work, some interesting experiments have been made in underplanting or sowing with *Dipterocarpus turbinatus* and *Dichopsis polyantha* to teak and *Gmelina*, as well as planting in mixture with the latter. *Gmelina* as a pure crop is now a back number in Chittagong owing to the havoc wrought by *Loranthus* which suddenly spread with surprising rapidity through the plantations and virtually wiped some of them out. It may still have a future as scattered trees retained from original mixtures with the evergreens, such as are now under trial. Some of these underplanting experiments have been really successful though it may be doubted whether they foreshadow a likely common future practice.

There is no great problem of an understorey for teak in this tract which is, of course, well-known for its large bamboo production. Undersowing or planting experiments with bamboo have had various difficulties to contend with and cannot show much in the way of results, but the natural re-growth is excellent in many places especially where the canopy is not too dense, and a double revenue already is realised

from some plantations (Plate 38). It looks as if a bamboo (mainly *Melocanna*) undergrowth is more likely to be a sound financial proposition than any underplanted tree species, and the economies of the matter are worth going into.

One of the difficulties experienced with bamboo planting is worth recording though it is not connected with the underplanting investigations and concerns a different locality. Here there was no question but that the bamboo was being steadily exterminated by unregulated cutting, all suggestions made in the interests of the local population and cutters to check the destruction having been completely turned down as inflicting undue hardship and involving undue interference with peaceful and deserving folk. It was thought that the only other remedy possible was to restock some of the depleted forests by planting, and a start was made. Casualties involving the complete disappearance of the young plants were numerous, but presently an abnormal increase was observed in the number of bamboos planted in the villages on the far side from the foresters' quarters! To make quite sure that no culm, not even a little one escapes cutting,—umbrella handles are taken out at Rs. -/12/- per thousand—but I am not sure that the full possibilities of the bamboo hookah stem, and the bamboo pen have yet been exhausted in this locality. For the other side of the picture, it must be noted that the steady depletion of the more accessible bamboo stocks throughout the tract is fully realised by the forest staff and investigations are in progress to determine what should be done and what can be done to maintain the supply both in quantity and quality.

Like many other localities, Chittagong has not yet quite decided on the best method of raising teak in plantations, though transplanting is customary. There is a tendency at the moment to use a rather bigger transplant than formerly, with 4" of stem rather than four leaves. It may be suggested that it is likely that what is best depends on the details of the weather in the year in question. A few years ago, it was feared that the use of stumps was resulting in the introduction of rot into the stems, but systematic examination has failed to produce any evidence that it does this.

A 13-year-old plantation of *Gmelina arborea*, under-thinned at first, now well spaced with good bamboo (*Melocanna*) regrowth which was worked in 1930. The immediately adjoining teak plantation presents a similar appearance.

Kaptai, Chittagong Hill Tracts.

Sample plot in the 1891 Mahogany plantation under-thinning and remeasurement. Note the copious natural regeneration forming a dense lower storey.

Kaptai, Chittagong Hill Tracts.

The mahogany (*Swietenia macrophylla*) plantations are interesting. There is a small plantation of 1891 near Kaptai rest-house which despite past inadequate thinning is quite promising. The sample plot laid out in it in November 1928, showed height of 85 feet for 38 years with diameters up to 22" (Plate 39). As in S. India, the profuse natural regeneration all round the larger trees, is a marked feature. During the last few years, the area sown to this species has been largely determined by the amount of seed available, and the young plantations make quite a good showing. To spin out the small seed supply alternate line sowing with *Gmelina* has been tried, but owing to its more rapid and branchy growth, the *Gmelina* has required a lot of cutting back. It is suggested that *Lagerstrœmia flos-reginæ* might provide a better associate. Owing to the thin canopy of mahogany and the danger from weeds (particularly *Eupatorium*), *Tephrosia candida* is again needed as a cover crop in the pure plantation.

Bengal has certainly taken the lead in the matter of setting aside sample areas of adequate size and accessibility of its chief forest types, particularly in the ever dwindling areas not yet traversed by fellings, for the benefit of future generations of foresters and others, including the general public which theoretically at least will some day be educated up to appreciating such things. The Mainimukh Preservation Plot of 100 acres is one of the most interesting I have seen, and is only one of many in the province.

Another Bengal speciality, though they are better seen in North Bengal than South, are the linear plots—we have sometimes heard them referred to as linear lines, but do not feel that this is an improvement—cutting through the mixed forests for a mile or more. All the larger trees are numbered, callipered and gradually identified, and the result is most useful, supplying otherwise unavailable data as to the composition, qualitative and quantitative of thet ype of forest, rates of growth, authentically determined trees for seed and specimen collection, and for observations on seeding, natural regeneration and so on. I know of no recent innovation better worth copying, and the lines can be very advantageously combined with the Preservation Plots, if care is taken not to disfigure the trees in any way.

To conclude, I would predict a big future for these forests. In their extensive and increasing plantation area, a valuable property is being built up in the right sort of locality. There are still large, if rather remote areas of unworked evergreen forest with fine timber, and there is little doubt but that in a few years the Divisional Forest Officer will be doing his touring (his inspections too if he's lazy) by hydroplane.

INTERIM REPORT ON THE AIR-SEASONING EXPERIMENT ON SOFTWOOD RAILWAY SLEEPERS AT DHILWAN IN THE PUNJAB

By S. N. Kapur, Officer-in-Charge, Seasoning Section, Dehra Dun.

The experiment was started in the middle of December, 1933, at Dhilwan in the Punjab, to study the best method of seasoning softwood railway sleepers. Three species were included in the experiment, namely deodar, fir and chir.

The sleepers were passed wet immediately after they were taken out of the river and carted to the depot. About 800 sleepers of each species were stacked in the "1 and 9" method, and about 1600 in the close crib manner. Out of the latter, about half the number of stacks were broken up after 7 weeks' seasoning and the sleepers were re-stacked in the "1 and 9" manner. At the end of 3 months' seasoning all the stacks were broken up, and the sleepers were passed by the same officer who had passed them originally, to determine the effect of the different methods of stacking and end-protection. After passing, the sleepers were again re-stacked for further observation.

A number of sleepers were weighed in the beginning and included in various stacks in such a manner that they could be taken out for re-weighing at intervals. These sleepers were weighed initially on 13th December 1933, and again on 8th January 1934, 7th February 1934 and 15th March 1934. The loss in weight of these sleepers during the course of seasoning, as well as the number of rejections on account of seasoning losses at the time of re-passing on 16th March 1934, are

shown in table 1. At the time the sleepers were spread out for re-passing, the moisture content of a number of sleepers from each stack was determined by means of an electric moisture meter. From the data obtained so far, the following observations can be made :—

1. *Rate of Seasoning.*

DEODAR.—The initial moisture content varied from 25% to 65%, the average being about 35%. During the first 3 weeks, the sleepers in the open stacks lost a little more moisture than those stacked in the close crib method, but subsequently the loss in weight became very much the same in the two kinds of stacks. At the end of 3 months, practically all the sleepers showed a moisture content above the fibre saturation point at a depth of 1″ from the surface, the sleepers from the close crib stacks being slightly wetter than those from the open stacks, but the difference was not very marked.

FIR.—In the fir sleepers the moisture content varied from 30% to 75% or more, the average being about 40%. The loss in weight of the sample sleepers was greater than that in the case of deodar, but here again the difference in the rate of drying between the open and close methods of stacking is not very marked. The moisture test results at the end of 3 months were more or less similar to those of deodar, most of the sleepers having a moisture content above 24% at a depth of 1″ from the surface.

CHIR.—The average moisture content at the beginning was 40% or more, a considerable proportion of moisture being distributed in the surface layers. The sleepers in the open stacks lost moisture very rapidly, the average loss during 3 months being 34 lb. per sleeper, as against 12 lb. in the close crib sleepers. At the end of 7 weeks all the close crib stacks showed a vigorous growth of mould and wood-destroying fungi on the sleepers, and it was considered risky to continue the stacking of the experimental sleepers in that manner. For this reason all the stacks (except one in the close crib manner) were opened out, and the sleepers were re-stacked in the "1 and 9" method. At the end of 3 months, the sleepers in the one close crib stack were still wet on the surface, and showed profuse fungus growth. Tests

at the time of re-passing of the sleepers indicated in most cases a moisture content above the fibre saturation point at a depth of $1\frac{1}{2}''$ from the surface.

Tests were taken on a number of sleepers which had been left stacked at the Depot for about a year, and it was found that they had a moisture content of 10% to 14% from the surface to the centre. It is, therefore, quite evident that none of the sleepers had yet seasoned sufficiently to be fit for use.

2. *Seasoning losses.*

DEODAR.—The sleepers with ends painted with low viscosity tar obtained from the Shalimar Paint Works showed decidedly fewer rejections due to seasoning degrade than those not so treated.

If the end of sleepers are properly protected, there is not much to choose between the 2 methods of stacking. Sleepers can be left stacked in close crib manner without any danger from fungus attack. It should, however, be noted that within a period of 3 months during the winter, deodar sleepers do not become sufficiently seasoned to be fit for use in the line.

FIR.—Some of the sleepers were end-coated with sludge from the creosote and oil tanks and these were found to split and crack much less than the uncoated sleepers, although the difference was not so marked as in the case of the tar coating on deodar sleepers.

End-painting is decidedly beneficial, and it is not improbable that low viscosity tar might have given still better results. Except in one stack, which was situated next to a close crib chir stack, no fungus or rot was noticed in any of the fir sleepers. Close crib stacking appears to be suitable and should give good results, if carried out under a water-tight roof on dry ground.

CHIR.—No end-tarring was done in this case, as all the sleepers had been end-tarred in the forest. A second coat of tar at the depot would however have been advantageous.

Close crib stacking is decidedly risky in the case of chir, on account of its liability to rot and decay. The only method applicable

is open stacking with free ventilation for rapid surface drying. End-coating should be tried.

3. *General.*

The stacks were built in such a manner that they were in lines with $2\frac{1}{2}$ feet wide alleys between them running in a NNW direction *i.e.*, in the direction of the prevailing dry winds. In order to protect the ends against rapid drying, the ends of adjacent stacks were placed as close together as possible, and it was noticed at the time of the last visit that this arrangement helped considerably in preventing end-splitting of the sleepers.

All the stacks were covered over on top with *sarkana* grass and earth, and the alleys were roofed over with old sleepers, so that there was ample protection against too rapid drying. This arrangement proved quite suitable and in fact prevented a lot of splitting and cracking that might have taken place in the course of ordinary stacking as followed in most timber depots. The rate of drying was no doubt retarded, but if good results are desired slow seasoning is essential.

Recommendations.

1. All sleepers should be end-coated with thick tar or some other suitable material as soon as possible after the sleepers are taken out of water.

2. Deodar, and very likely fir, can be stacked in the close crib manner after end-painting, provided the stacks are protected against too rapid drying from the ends and the top. Chir sleepers should be stacked in the " 1 and 9 " method.

3. Seasoning should be continued till the sleepers are fully dry. The exact period necessary to achieve this will be known at the end of the experiment, but it is, in any case, much longer than 3 months.

TABLE I.

Species.	Method of stacking.	Loss in weight of sample sleepers in pounds per sleeper.			Seasoning losses in sleepers with tarred ends.			Seasoning losses in sleepers with untreated ends.		
		15th Dec. 1933 to 8th Jany. 1934.	8th Jany. 1934 to 7th Feby. 1934.	7th Feby. 1934 to 15th March 1934.	No. of sleepers.	Rejections. No.	Rejections. %.	No. of sleepers.	Rejections. No.	Rejections. %.
DEODAR	1 & 9 ..	6.45	3.36	3.51	331	7	2.1	479	19	4.0
	Close crib ..	4.50	3.28	3.40	360	2	0.6	378	51	13.5
	Close crib followed by 1 & 9.	4.90	3.39	4.66	356	12	3.4	509	80	15.7
	Total ..	..	..	..	1047	21	2.0	1366	150	11.0
FIR...	1 & 9 ..	10.94	5.61	4.45	356	19	5.3	442	65	14.7
	Close crib ..	9.14	3.54	5.32	395	14	3.5	395	21	5.3
	Close crib followed by 1 & 9	8.30	5.11	9.52	392	34	8.7	415	63	15.2
	Total ..	..	..	..	1143	67	5.9	1252	139	11.1
CHIR	1 & 9 ..	17.61	8.62	8.08	..	..	..	819	62	7.6
	Close crib ..	4.12	3.21	4.96	..	..	..	129*	3	2.3
	Close crib followed by 1 &9	9.90	4.89	12.19	..	..	..	1469	93	6.3
	Total ..	..	..	..	..	..	..	2417	158	6.5

*At the end of 7 weeks, all the stacks were found to be badly fungus attacked and were opened out except one. After 3 months' stacking the fungus growth was still vigorous on the close stacked sleepers.

A SHORT TRIP THROUGH AFGHANISTAN

BY KHWAJA BARKAT ALI, DEPUTY POST-MASTER GENERAL, BOMBAY.

A trip to Kabul is not a trip to Hades. You go there as you go elsewhere with this difference that before crossing the border you have to obtain a passport from your own Government which should be endorsed by the Afghan official in Peshawar. Motor lorries carrying goods or passengers leave Peshawar for Kabul every day or every other day and a seat in one of them could be booked for anything between Rs. 10/- to Rs. 15/-. Leaving Peshawar in the morning you spend your first night somewhere beyond Jalalabad and reach Kabul next day usually before twelve. There is little danger on the way except when the tribes are in commotion, regarding which the traveller has to make enquiries and assure himself before departure from Peshawar. There should be no particular difficulty in arranging for the few meals on the way. The road is certainly not so good as desired. No particular difficulty may however be anticipated in motoring over it from end to end.

Kabul is a good place, its climate is excellent during summer and the people charming in more ways than one. If you wish to see palatial buildings there you are likely to be disappointed. The houses, leaving a few are all made of mud, though the rooms in those belonging to aristocracy or to wealthy merchants are kept clean and well furnished.

All necessities of life are available and fruit during summer is in abundance and cheap. There is a hotel run on European lines in which accommodation can be had at reasonable rates, *viz.*, Rs. 5/- to Rs. 7/- per day. The places of interest in the neighbourhood are :—(1) the tomb of Baber, the famous adventurer and the founder of Moghul dynasty in India, and (2) the city of Daru-ul-Aman founded by ex-King Amanullah. Both these places are within 5 to 6 miles from Kabul and are situated on a good road of which the Afghan administration may well be proud. Ghazni, the capital of the great Indian invader Sultan Mahmud, and Kandahar, the fruit garden of

Afghanistan, are within striking distance and are well worth a visit. If one will plan a trip from Peshawar to Kabul and thence to Ghazni and Kandahar and return to India *via* Chaman and Quetta he will probably find his holiday well spent. The cost would be quite moderate.

As stated already ordinarily travelling in Afghanistan is not attended with any kind of risk unless there is some political commotion in the country in which case the area affected no doubt becomes unsafe for a foreigner.

This should be taken subject to the condition that the writer's knowledge of the place is now about three years' old, and Kabul is a place of quick changes.

TREATED SLEEPERS IN INDIA *

In the *Indian Forester* of May 1934, Mr. H. M. Glover gave a brief review of the sleepers treated by the North Western Railway at the sleeper treating plant at Dhilwan. That review, instructive as it was, did not, however, tell the whole story, and the following remarks by the Chief Engineers of the North Western and Assam Bengal Railways respectively may be of interest as supplementary to Mr. Glover's contribution :—

North Western Railway.

From 1923 to 1933 nearly 4½ million sleepers have been treated at the N. W. Railway Creosoting Plant at Dhilwan with a mixture of creosote and liquid fuel oil, the treatment and the mixture used being that advised by the Forest Research Institute from time to time. The numbers treated included 2¾ million chir and 2 million fir. In addition to the 4½ million sleepers treated under pressure, sleepers were also treated by the dipping process between 1921 and 1923 as follows :—250,000 chir—of which 128,000 are still in the track (January 1934), and 322,500 fir—of which 156,000 are still in the track. In addition to these, approximately 237,300 chir treated by the dipping process by the U. P. Forest Department were supplied to the N. W. Railway and laid in the track between 1915 and 1918, of which

* A précis prepared by the Forest Economist, F. R. I., of the notes by the Chief Engineers of North Western and Assam Bengal Railways on their experience with treated sleepers.

119,000 are still in the track. Originally in America liquid fuel oil was introduced into creosoting treatment to lessen costs, but experience in the track there showed that sleepers treated with the mixture lasted better than those treated with creosote, the fuel oil preventing end-splitting or cracking, particularly in desert regions. The advice of the Forest Research Institute has been to increase the proportion of liquid fuel and decrease the percentage of creosote from time to time. Creosote treatment undoubtedly preserves sleepers for many years from white ant attack, but the most striking result is the reduction of checking and end-cracking in treated sleepers as compared with untreated, a very important matter, as cracking of the ends of sleepers with resultant failure of spike hold is the principal cause of sleepers becoming unserviceable and unfit for use in the track. Increased axle-loads and speeds, particularly on main lines, have increased the stresses in sleepers, and result in increased end-splitting of sleepers whose fibres have been unduly strained when drying out.

3. The 1926 experimental treatment of 760 B. G. deodar specially ordered by the Chief Engineer, (Mr. F. C. Pavry), is the most important experiment carried out at Dhilwan. 350 of these sleepers were laid in the track near Beas, in continuation of other 1926 deodar B. G. renewals, to ensure that conditions would be identical. Many of the untreated deodar have been attacked by termites, but, leaving out of consideration sleepers attacked in this way, inspection shows a very striking difference between the treated and untreated sleepers as regards checking, cracked ends and loose knots, and there is no doubt that the treated deodar will give at least 6 years' more life than the untreated that may happen to escape termite attack.

4. The fact that treatment is useless where sleepers have already suffered from bad fungus attack has been clearly illustrated by the fate of a large number of fir sleepers, part of the World War aftermath which were treated though attacked by fungus, the failure of which has greatly prejudiced the use of fir. The behaviour of sound fir sleepers treated in later years, however, encourages the continued use of fir, particularly of fully incised fir sleepers treated by the Rueping process.

5. Experience of the behaviour of treated sleepers in the track and of the way in which the various kinds of sleepers take treatment, leads one to the following conclusions :—

(A) That creosote is an adequate safeguard against termite attack ;

(B) That the preservative action of the oil will add at least 6 years to the life of deodar sleepers, probably 8 years to chir sleepers, 6 years to kail, and 4 to 6 years to fir sleepers by preserving them from checking and from end cracks ;

(C) That a treated chir sleeper may be expected to give almost as long a life as a treated deodar one, but that kail and fir will give shorter lives.

6. Taking into consideration the latest evidence published by the Forest Research Institute on the strength of timbers in conjunction with latest reports and inspections, I estimate the life in the track as follows and believe the estimate to be on a conservative basis.

Kind of sleeper.	In main line.	In branch lines.	Average on N.W. Railway.
	Years.	Years.	Years.
Untreated deodar (where no termites exist)	11	15	13
Treated deodar (*Cedrus deodara*)	17	21	19
Treated chir (*Pinus longifolia*) ..	16	20	18
Treated kail (*Pinus excelsa*) ..	12	16	14
Treated fir (*Abies pindrow*) ..	11	15	13

Assam Bengal Railway.

Impregnation at Naharkatiya is made with a mixture of half creosote and half earth oil, measured by volume. The creosote has

been imported from England, the earth oil is obtained from the adjacent oil field at Digboi. The average consumption of oils is creosote 3·66 lb. and earth oil 3·12 lb. per cubic foot of timber treated.

The cost of treatment is estimated at 13 annas 9 pies per cubic foot of timber treated with an outturn of 1,50,000 cubic feet per year or 11 annas 7 pies per cubic foot with an outturn of 3,00,000 cubic feet per year, these figures cover all costs from the arrival of the timber in wagons at the plant station to its despatch loaded in wagons, and includes interest @5% and depreciation @5% on the cost of the plant. 90% of the timbers treated are of hollong (*Dipterocarpus macrocarpus*), hollock (*Terminalia macrocarpus*), *jutili* (*Altingia excelsa*), *sam* (*Artocarpus chaplasha*), and are given above in the order of their bulk in the supply, the remaining 10% are made up of woods that are likely to yield a good sleeper. The following timbers are no longer accepted for treatment: *otenga* (*Dillenia indica*), *ajhar* (*Lagerstrœmia flos reginæ*) *karoi* (*Albizzia procera*), *gahori sapa* (*Magnolia* spp.)

The plant started operating in May 1929. Due to delays in the supply of the machinery of the plant from England, and incomplete stacking grounds at Naharkatiya, it had at first to deal with sleepers that under the circumstances had been prematurely cut. At that time expert opinions differed as to whether these sleepers had deteriorated too far to treat or not. Actually some 2,21,000 were treated from this premature supply during the year 1929-1930. It was afterwards found that very many of them were failures, and from this lot the Assam Bengal Railway wrote off 42,318 and the E. B. Railway 6,798, without putting them into the track. This unfortunate start gave the Naharkatiya sleeper a very bad name and although subsequent supplies have in our opinion been satisfactory we have not been able to overcome the prejudice that the first failures had created.

Since the commencement of operation in May 1929 up to the 31st December 1933, the plant has treated 9,62,187 metre gauge sleepers; of these half have been issued to the E. B. Railway and half to the A. B. Railway.

The A. B. Railway in its track maintenance adopts the random method of sleeper renewal, and it is unfortunately impossible to

separate the first year's supply from subsequent out-turns, so it must be borne in mind that the following figures include the replacements among the 80,000 sleepers of the first year's manufacture that did go into the track. Under these circumstances the results appear satisfactory.

Year.		Put in track.	Total in track.	No. taken out of track.
1929-30	..	32,799	32,799	128
1930-31	..	94,376	1,27,175	319
1931-32	..	1,04,077	2,31,252	5,154
1932-33	..	1,26,894	3,58,146	8,800

The E. B. Railway do their sleeper renewal in complete through engths of track and are therefore able to separate the first year's supply from subsequent years, but it is seen from their figures that many of the first year's supply were put into the track a year later.

1929-30	..	47,085	47,085	nil.
1930-31	..	1,14,764	1,61,849	nil.
1931-32	..	88,480	2,50,329	nil.
1932-33	..	1,10,057	3,60,386	nil.

These are surprisingly good results, and should in a few years' time yield figures that will enable the life of the Naharkatiya sleeper to be forecast with some degree of certainty.

Generally the appearance of the treated sleeper in the track is excellent, and in my opinion they promise a long life. At the same time such an opinion can only be formed by disregarding the obvious failures. These failures cannot with certainty be laid to the first year's out-turn, appearance is no guide, as old or new, these sleepers retain their new appearance. The failures consist of a complete loss of mechanical strength in the timber.

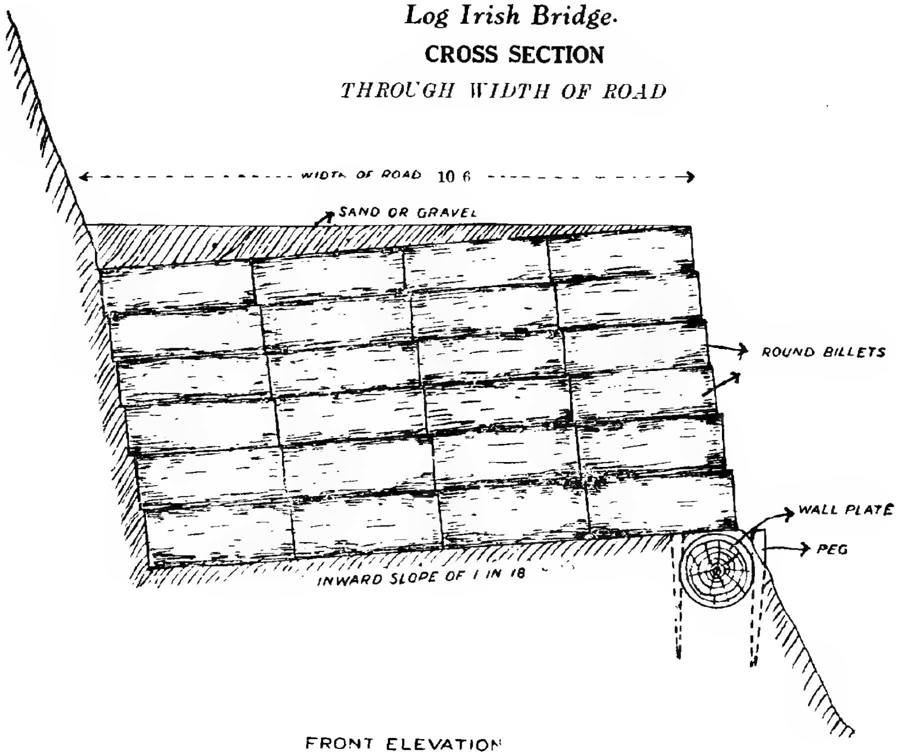
No test lengths laid from our plant have yet been in the track long enough to give any useful information, but we have had small

Figure I.

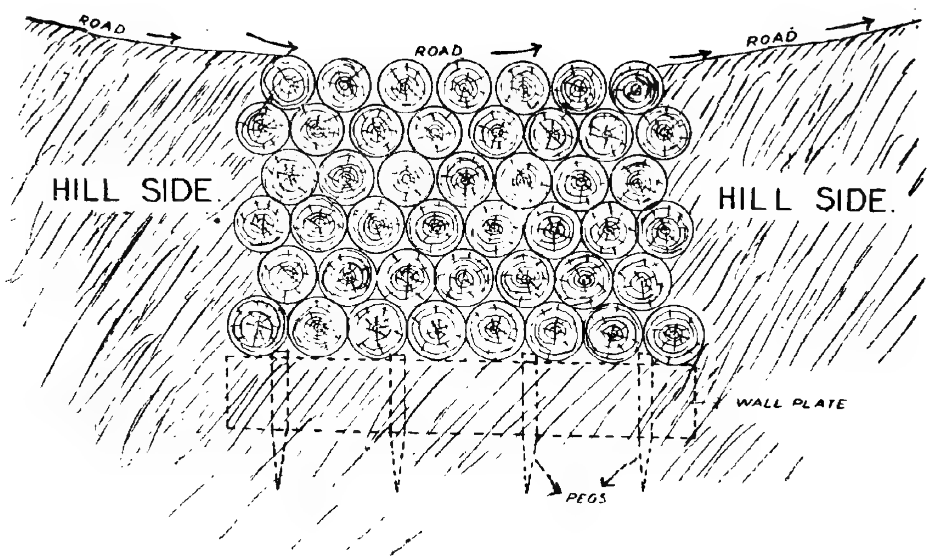
Log Irish Bridge.

CROSS SECTION

THROUGH WIDTH OF ROAD



FRONT ELEVATION



test lengths of similarly treated sleepers in the road for many years which yield the following results :—

Timber.	Date laid.	No. laid.	Renewals to Dec. 1934.	Average life.
Hollock, *Terminalia myriocarpa* ..	Dec. 1915 ..	89	44	19
Sam, *Artocarpus chaplasha* ..	,, ,, ..	25	14	18
Jutili, *Altingia excelsa* ..	,, ,, ..	23	13	20
Gahorisapa, *Magnolia* spp. ..	,, ,, ..	21	14	17
Jutili, *Altingia excelsa* ..	,, 1916 ..	42	21	18
Hollong, *D. macrocarpus* ..	,, ,, ..	49	17	20
Hollock, *Terminalia myriocarpa* ..	,, ,, ..	48	14	21
Hollong, *D. macrocarpus* ..	Nov. 1923 ..	202	63	12
Sam, *Artocarpus chaplasha* ..	July 1927 ..	169	2	18
Paroli, *Stereospermum chelonoides* ..	,, ,, ..	167	1	20
Karoi, *Albizzia procera* ..	Octr. 1930 ..	179	..	..
Jutili, *Altingia excelsa* ..	,, ,, ..	349	..	..

The average life shown is based on Chart, page 9 of the Quarterly Technical Bulletin Vol. 1, No. V, of April 1927, and this chart had been prepared from U. S. Madison figures of the relation between replacements and average life.

In conclusion I may say that in my opinion I believe that the treated sleeper may be expected to give us an average 19 years' life, but we have yet to make certain that we can eliminate before treatment those sleepers which for some reason show early and complete failure of mechanical strength.

USEFUL HINTS ON FOREST BRIDGES

By A. J. S. Butterwick, Deputy Conservator of Forests.

In the hope that the writer's experience in the construction of forest roads and bridges in Burma may prove useful to other forest officers, the following notes are recorded.

I.—Log Irish Bridges (See Plate 40).

Irish bridges are made on a hill road in places where small streams cross it. Irish bridges are generally made of stone but in some places in Burma it is very difficult to obtain suitable stone in sufficient quantities. The writer has found that round billets of durable timber do equally well if not better than stones.

The drawing (Plate 40) shows how these Log Irish bridges are made. The following points are essential for success in their construction :—

(a) The bed should be dug out with an inward slope of about 1 in 18.

(b) The wall plate should be about 18″ in diameter of some durable timber like *pyingado*, or *thingan* (*Hopea odorata*) or refuse teak.

(c) The billets too must be of a durable timber like *pyingado*, *thingan* or refuse teak. A convenient size for handling each billet is about 2 feet to 3 feet long and 12″ to 18″ in diameter. The largest billets should be put in the lower layers and towards the outside.

Such Log Irish bridges do not need skilled labour, are easily and cheaply made, and, if fire protected, will last very long. They need scarcely any repairs. The writer has made several of such Log Irish bridges for cart and elephant traffic, some being over 10′ high, and they have now lasted over 5 years without needing any repairs and are still going strong.

II.—Log bridges or Hningyans (*Burmese*). (See Plate 41).

In out-of-the-way forests in Burma sawyers and carpenters can be had only with great difficulty and at a high cost. In such localities therefore, a sawn timber bridge is very expensive to make. A rough log bridge built, as shown in Plate 41 attached, serves the purpose just as well.

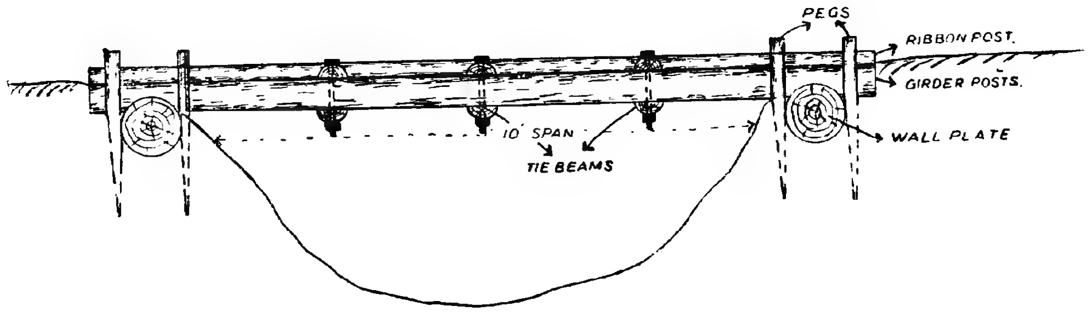
Such bridges, or as the Burmese call them *hningyans*, are constructed as follows :—

(a) The two wall plates should be made of logs of durable timber each about 18″ to 24″ in diameter. Their length will vary according as the bridge is meant for cart or elephant traffic. Each wall plate should be embedded firmly in stable soil and fixed by means of two pairs of stout pegs driven deep into the ground at either end. Each wall plate is notched about 6″ deep on the upper surface leaving about 1′ unnotched at each end.

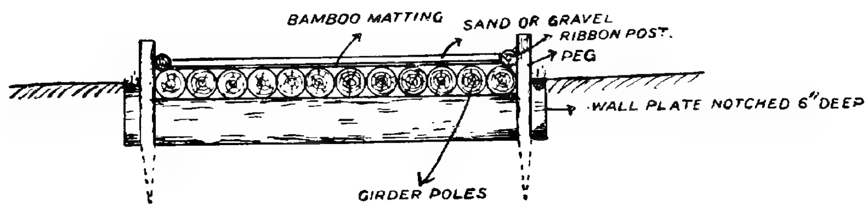
Figure II.

Log Bridge or Hningyan.

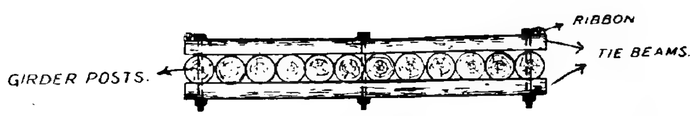
SIDE ELEVATION



CROSS SECTION NEAR WALL PLATE



CROSS SECTION NEAR TIE BEAM



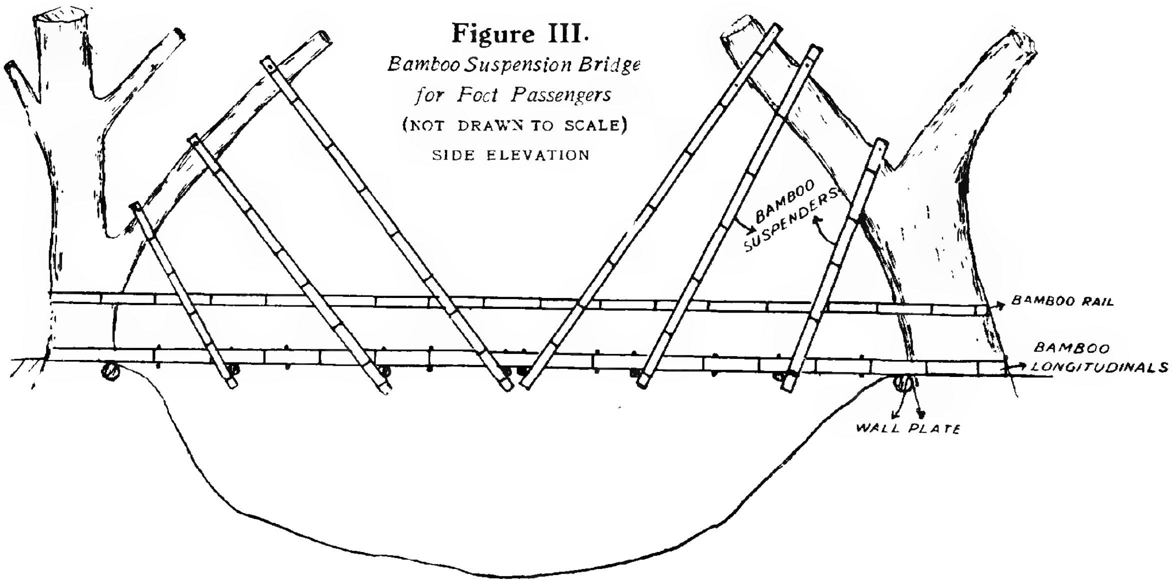
Showing end Elevation.

Figure III.

Bamboo Suspension Bridge for Foot Passengers

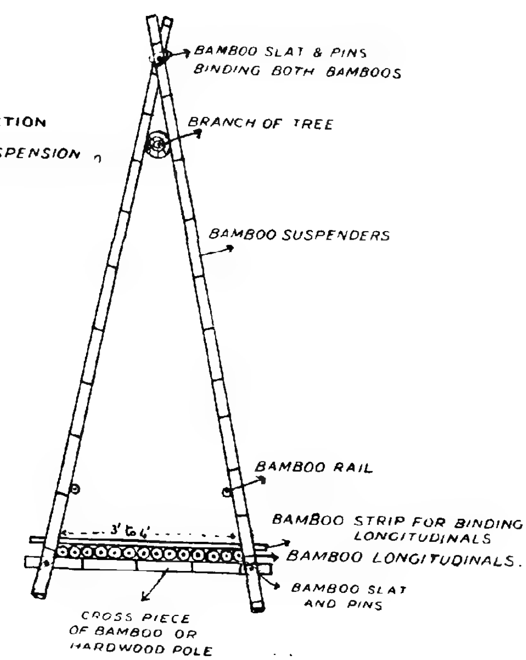
(NOT DRAWN TO SCALE)

SIDE ELEVATION



CROSS SECTION

TO SHOW THE SUSPENSION



(*b*) On the two wall plates are arranged as many pole girders as can be fitted inside the notched surfaces of the opposite wall plates. These pole girders should touch one another and must be of some durable timber (teak poles obtained in thinnings are useful). These should not be less than 12″ in diameter at the larger end.

(*c*) These pole girders are securely tied together at intervals by pairs of tie beams, which are bolted together as shown in the drawing. Such tie beams are best made by splitting straight poles in halves. The numbers of tie beams required will depend on the length of the bridge. For a bridge of 20′ span, 3 pairs of tie beams will be required as shown in the drawing.

(*d*) Over the pole girders and tie beams, a bamboo mat is placed and kept in position by means of two thin poles which run along the sides of the bridge and are tied firmly to the pegs of the wall plates.

(*e*) A layer of sandy loam or gravel about 3″ deep is spread over the bamboo matting.

A bridge of 20′ span, as specified above, and as shown in the drawing, will carry safely a loaded cart or an elephant. It is made easily, quickly, and cheaply, and if kept in repair and fire protected will last for years. The only repairs ordinarily needed are the bamboo matting and sandy loam which may have to be renewed every year at the end of the rains. It is not advisable to make such bridges of more than 20′ span for loaded carts and elephants.

III.—Temporary bamboo bridges for foot passengers.—(See Plate 42 and photograph in Plate 41).

In the forests of Burma, during the rains, it is very difficult and troublesome to cross the larger streams when in spate and sometimes one has to sit for hours on bank to wait for the water to subside. Messrs. Foucar and Co., teak lessees, have made a few very useful temporary bamboo bridges for foot passengers over some of the main

streams in their concession area, and the writer is indebted to Mr. C. G. Merton, Assistant of that firm, for the photo and details.

These bridges can be built over any reasonable sized stream provided there is a tree on either bank opposite to each other with a stout branch overhanging the water.

A man climbs up on to the overhanging branch of one tree, whilst another man gets on to the tree on opposite bank.

Two straight sound bamboos are passed to each man who secures them together by means of a bamboo slat passed through a hole near the end of each bamboo, and then binds the joint thus made with strong *hnis* (green bamboo strips) or *shaw* (*Sterculia*) ropes. These 2 bamboos are then slipped over the branch of the tree and allowed to hang down. The men on each bank now fit a cross piece securely at the lower ends of the pair of suspended bamboos so as to form a triangle, the base being about 3′ to 4′ wide. This cross piece must be strong and should be made from either *myinwa* bamboo (*Dendrocalamus strictus*) or a pole of some tough wood. The men on the bank then tie two bamboos at each end of the cross piece and with these two bamboos gently push the triangle thus suspended away from the bank. This triangle is p shed out about 5′ to 8′ from the bank, and the 2 propelling bamboos are then fastened to the bank. More bamboos are then laid between the bank and bamboo triangle to form the floor of the bridge and these are bound together at intervals by means of cross bamboo strips. A second pair of bamboos longer than the first pair is then passed up to each men on the trees. He secures this second pair in the same way as he did the first, but places the second pair on the branch just above the first pair. Each second pair of bamboos is then fastened with a strong cross piece as before to form a base and pushed out for about 5′ to 8′. In this way the bridge is built out from each bank so as to meet in the centre. A line of bamboos is then tied about 3′ above the floor on to the suspending bamboos on both sides. These add stability to the bridge and form the rails for the passengers. For wide streams it will be found advisable to use *yamata* (*C. latifolius*) canes for the longer suspenders instead of bamboos.

The bridge in the photo published has a span of about 150′ and was used throughout the rains. It was built in 2 days by 6 men, the longest job being the cutting of the bamboos and the making of the *hnis* (green bamboo strips), and *shaw* rope. Such a bridge will last for one year and can be used by foot passengers only. It however costs very little to make and certainly does save a lot of time and trouble during the rains. Needless to say it must be built above the highest flood level.

PEGU,
10*th April*, 1934.

STUDIES IN SPIKE DISEASE OF SANDAL

I. TWO TYPE OF SPIKE DISEASE.

II. THE MOVEMENT OF THE VIRUS IN SANDAL PLANTS.

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AND K. GOPALAIYENGAR M.SC., BOTANICAL ASSISTANT.

(A) TWO TYPES OF SPIKE DISEASE OF SANDAL.

Introduction.

The first published record of spike disease of sandal is contained in the record of the Forest Administration in Coorg for the years 1898-99. In the year 1917, Coleman (3) established its highly infectious nature, and held a conference of forest officers from Coorg, Madras, Mysore and Forest Institute, Dehra Dun, to discuss the subject. At this conference Hearsey (4) described two kinds of spike disease which he called the first and second form of spike. The first form of spike was considered to be a kind of lanky degeneration, indicated by " the rapid formation of leaves and their rapid fall, the lengthening of the internodes, then the dropping of the long pendulous branchlets and the formation of long thin limp leaves." The second type was called the true official form of spike the symptoms of which were well-known. While Lushington (5) agreed with this view, Macarthy (6) conisdered that " the lanky growth is not spike, much

less should it be styled a preliminary form of spike " as it was brought about by the change of certain environmental conditions. Coleman could not find any excess of starch in the leaves and twigs of the lanky form. Rama Rao (10) differentiated three different types as follows :—

(1) Lanky Form.
(2) The normal spike with—
  (*a*) normal coloured leaves.
  (*b*) copper coloured leaves.
(3) The weeping type.

The third type was described as the usual spike, with pendulous branches, in which the leaves are larger, golden yellow in colour and crowded at ends of branchlets, and resemble weeping willows. Ramaiengar (9) supported the view of the existence of this type, but several of the other members in the spike disease conference stated that they had seen this type of growth in apparently healthy trees and therefore did not consider that it was necessarily to be looked upon as a type of spike.

Subsequent workers on spike disease of sandal have not been able to differentiate any types of spike disease and hence at present only one type is recognised.

In our investigations, we found the lanky form described by Hearsey to be no type of spike at all, and non-infectious. As regards spiked trees with copper coloured and normal coloured leaves, there is no other difference between the two, except in the colouration. The varieties of sandal have been divided into two groups pigmented and unpigmented by Venkata Rao Badami and M. G. Venkata Rao (13). The former contain a gradation in the intensity of pigmentation varying from a light touch of pink to deep purple. In healthy trees this colouration is seen only in the youngest leaves at the tips of growing shoots, in flowers, in the inner floral parts of even the youngest flower buds, and in the endocarp of green fruits.

Some of these pigmented types of sandal when affected by spike disease develop deep copper coloured spiked leaves all over the tree. All the coloured types do not develop such leaves, but only a few in

Plate 43.

Fig. 1

Healthy sandal (host shaded off).

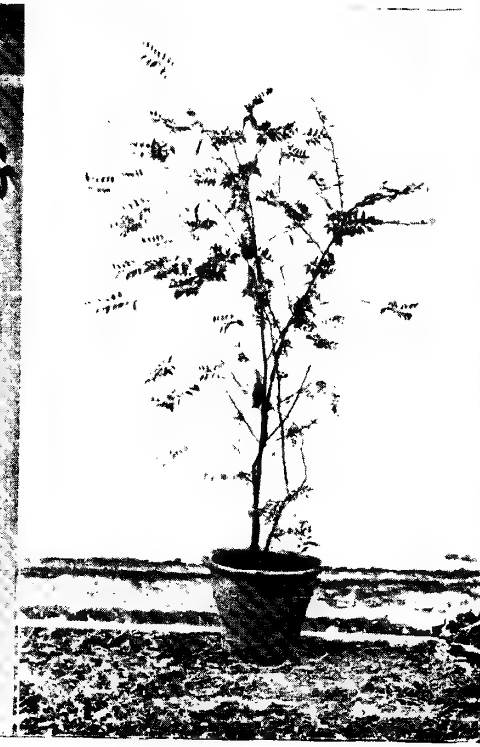


Fig. 2

A fully diseased sandal, inoculated with Pendulous type of spike disease grown with an *Acacia* host. Long drooping twigs and absence of clusters of shoots are conspicuous.

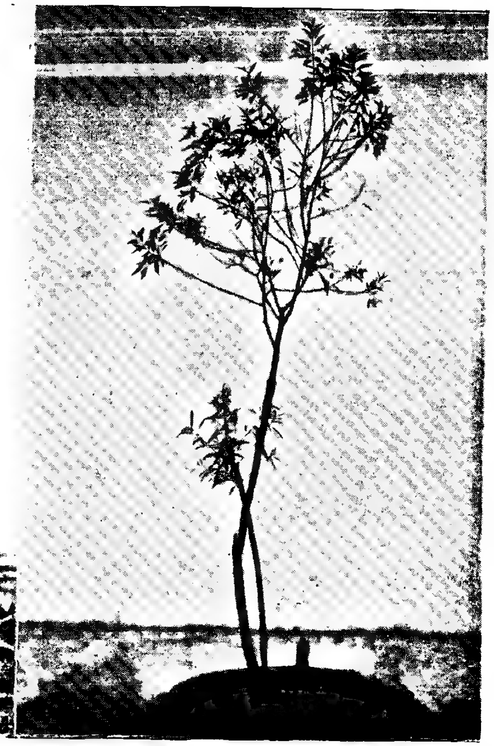


Fig. 3

A fully diseased sandal inoculated with Rosette type of spike disease and the *Acacia* host cut off at the time of taking the picture. Short stiff clusters of spiked shoots are prominently seen.

which the pigmentation is of medium intensity. These copper coloured spiked leaves are never found in any of the unpigmented varieties of sandal. Several unpigmented varieties of sandal in pot-cultures were inoculated with material taken from trees with copper coloured spiked leaves but all of them developed only uncoloured spiked leaves. It is therefore obvious that the difference in the colouration of spiked leaves does not indicate any type of spike disease, but only the reaction of the disease on the anthocyanin contents of certain sandal varieties.

Two distinct types of Spike disease differentiated.

In the course of our field observations, we have met with several spiked trees noted by Rama Rao (10) as the weeping type. Such trees though not common in all the infected areas were found in large numbers in the spiked areas of Hirehalli in Tumkur District, Gobli forest in Hassan District, and in Gulladahalla forest of Hunsur near Coorg frontier in Mysore District. In the beginning we thought that this type was simply the effect of the spike disease on the variety of sandal with pendulous branchlets, but subsequent inoculation experiments revealed it as a distinct type of spike disease. We propose to call this strain of the disease the Pendulous type and the other which is the common erect form the Rosette type (Plate 43, figs. 2 and 3).

The following are the main differences in symptoms between the two types of spike disease :—

(1) In the Pendulous type, the individual infected shoots show continuous apical growth and attain lengths of 1 to 3 feet, the leaves being confined to half to one-third the length from the growing tip. The growth in the length of the shoots being disproportionate to that in thickness, the infected twigs assume a conspicuous drooping habit. In the Rosette type the spiked shoots are less than one-third the length of those in the Pendulous type and grow stiff and erect.

(2) Dormant buds on spiked shoots in the Pendulous type do not develop and grow at all and hence excessive branchlets and

clusters of shoots found in the Rosette type are conspicuous by their absence (Plate 44, figs. 1 and 2).

(3) The area of the leaf blade is two to three times larger in the Pendulous type than in the other type, and the petiole and internodes are also correspondingly longer.

The reduction in the breadth of the leaf in the Pendulous type is less than the reduction in length, and hence the leaves in this type look conspicuously broader than in the Rosette type. (Plate 44, figs 1 and 2). We have come across cases in the pendulous type where the leaves were so large as to resemble healthy leaves and only the arrangement of leaves, their yellow colour and partial stiffness, indicated the infection.

(4) In the Rosette type, spiked shoots never develop any flowers. In the Pendulous type, though generally no flowers grow on spiked shoots, a few spiked twigs of an infected tree sometimes produce flowers which may be normal or abnormal, and in the former, fruits sometimes develop. Except phyllody, the formation of abnormal flowers sometimes found in apparently healthy branches of infected trees has not been described till now. In these flowers, the buds are considerably reduced in size, pedicels abnormally elongated 3 to 4 times the normal length. Anthers often develop a reddish discolouration, and the pistil is abnormally developed into a thick long cylindrical body with the top portion bent on itself in the bud (Plate 45, fig. 2). We have come across cases where the formation of such abnormal flowers was the first symptom of the disease to be seen before spike appeared. These flowers are sterile and do not form fruits.

(5) In the Pendulous type the root ends and haustoria do not die soon after the spiked leaves develop as in the Rosette type. Plants in which the former type of disease was a year old have been examined and in these nearly half the number of roots and haustoria were still quite healthy and new ones were being formed. Naturally as the root ends and haustoria function for a long period in the Pendulous type, infected plants survive much longer than in the

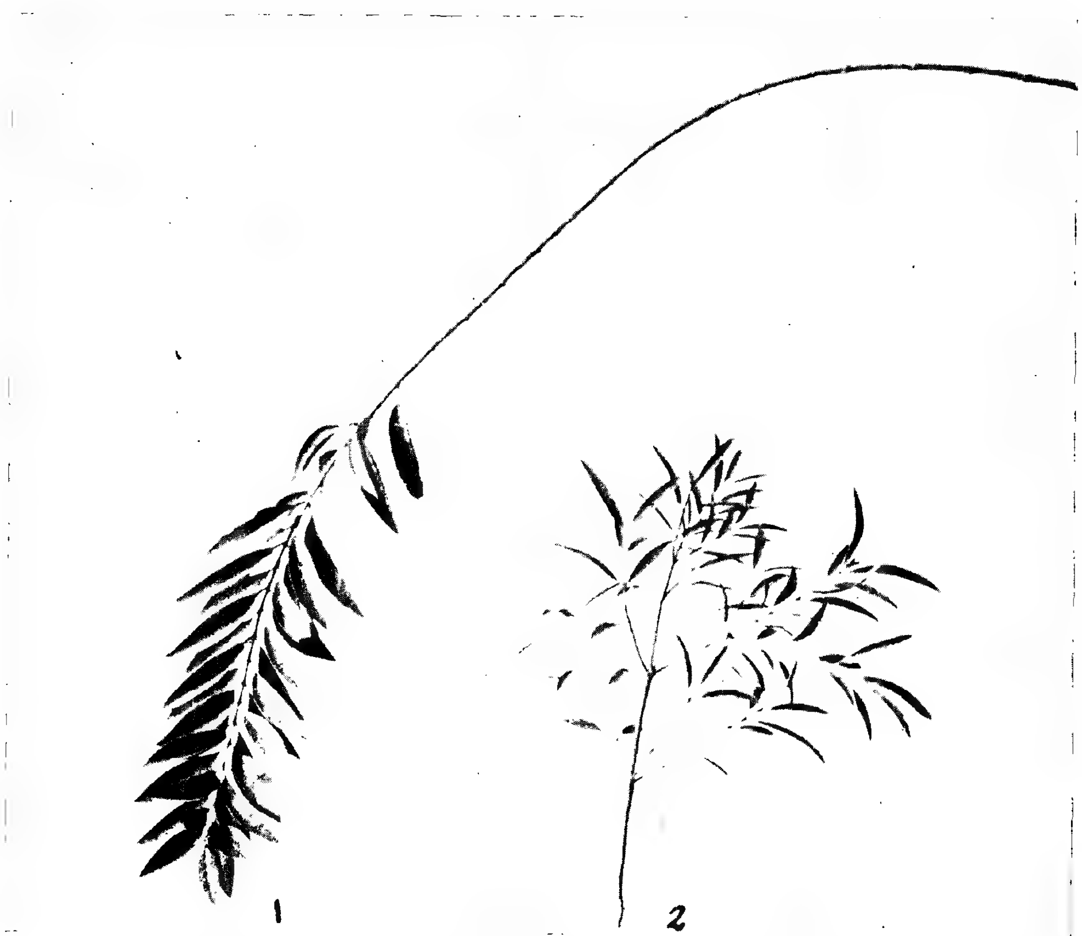


FIG. 1.—A twig of sandal affected with Pendulous type of spike disease, showing abnormal apical growth of shoots and broad leaves.
FIG. 2.—A twig of sandal affected with Rosette type of spike disease, showing dwarfed clusters of shoots with narrow stiff leaves.

Fig. 1.

Fork A.—Twig grafted with Pendulous type. The drooping long twigs have been tied up with a string to leave the other fork clear.

Fork B.—Twig grafted with Rosette type. The oldest spiked shoot at tip of the graft is just getting into an intermediate form resulting from a combination of two types.

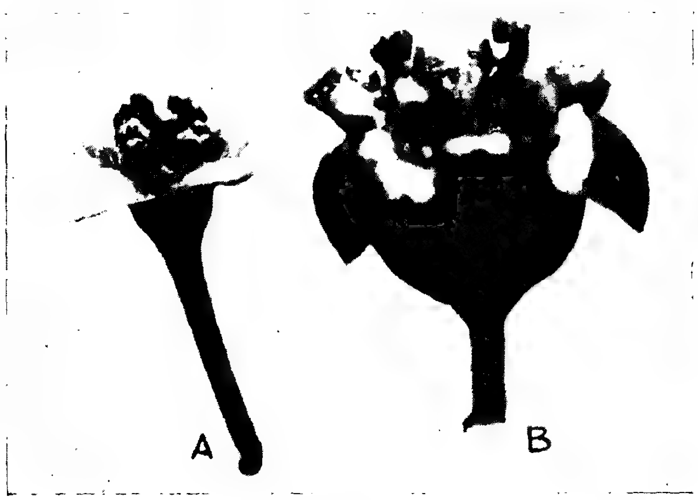


Fig. 2.

A.—Abnormal flower of sandal found on apparently healthy branches of spiked trees.

B.—Normal flower of sandal.

other type. Among the plants under observation affected by the former, while a few have succumbed in two to three years, the majority are still living. It appears possible that in this type the plants may survive 3 to 5 years against to $2\frac{1}{2}$ years in the Rosette type. A sandal tree in the office compound inoculated with the pendulous type of the disease from material collected in Gobli State forest $3\frac{1}{2}$ years ago has still plenty of vitality.

Transmission of the disease of the Pendulous type by inoculation.

As virus diseases are recognisable mainly by their symptoms and their infectivity, these are the two aspects of the problem which have to be studied. To ascertain experimentally if the Pendulous type is a distinct form of spike disease, 30 sandal plants in pots and in the ground were inoculated with this strain of the disease. The inoculations were successful in 18 cases which included different varieties of sandal. The inoculations were also conducted in different methods, *viz.*, twig-grafts, budding, bark-grafts and leaf-insertion (12). In all cases the disease was reproduced true to the parent strain, with all its distinguishing characters. Diseased leaves from the infected trees in the office compound mentioned in the previous para were examined by Narasimhan (8) and intracellular bodies were found as in the Rosette type.

Combination of the two strains of Spike disease.

To ascertain the resultant effect of combining the two types of spike disease, six forked plants in pot-cultures were inoculated with twig-grafts, and the two strains of the disease were introduced on every plant, one on each fork. The scions developed true to the parent strains and the types spread to the forks below retaining their characters (Plate 45, fig. 1). But later on shoots appeared on the stock, which were intermediate in character between the two strains. In this combined form, there is a certain amount of excessive branching as in the Rosette type, but the leaves are a little broader and twigs grow longer than in the Rosette type, with a marked tendency for drooping. The root-ends however appear to die quickly as in the Rosette type. Such intermediate types are commonly met with in the localities where both strains of the disease are found.

II. THE MOVEMENT OF THE VIRUS OF SPIKE DISEASE IN SANDAL.

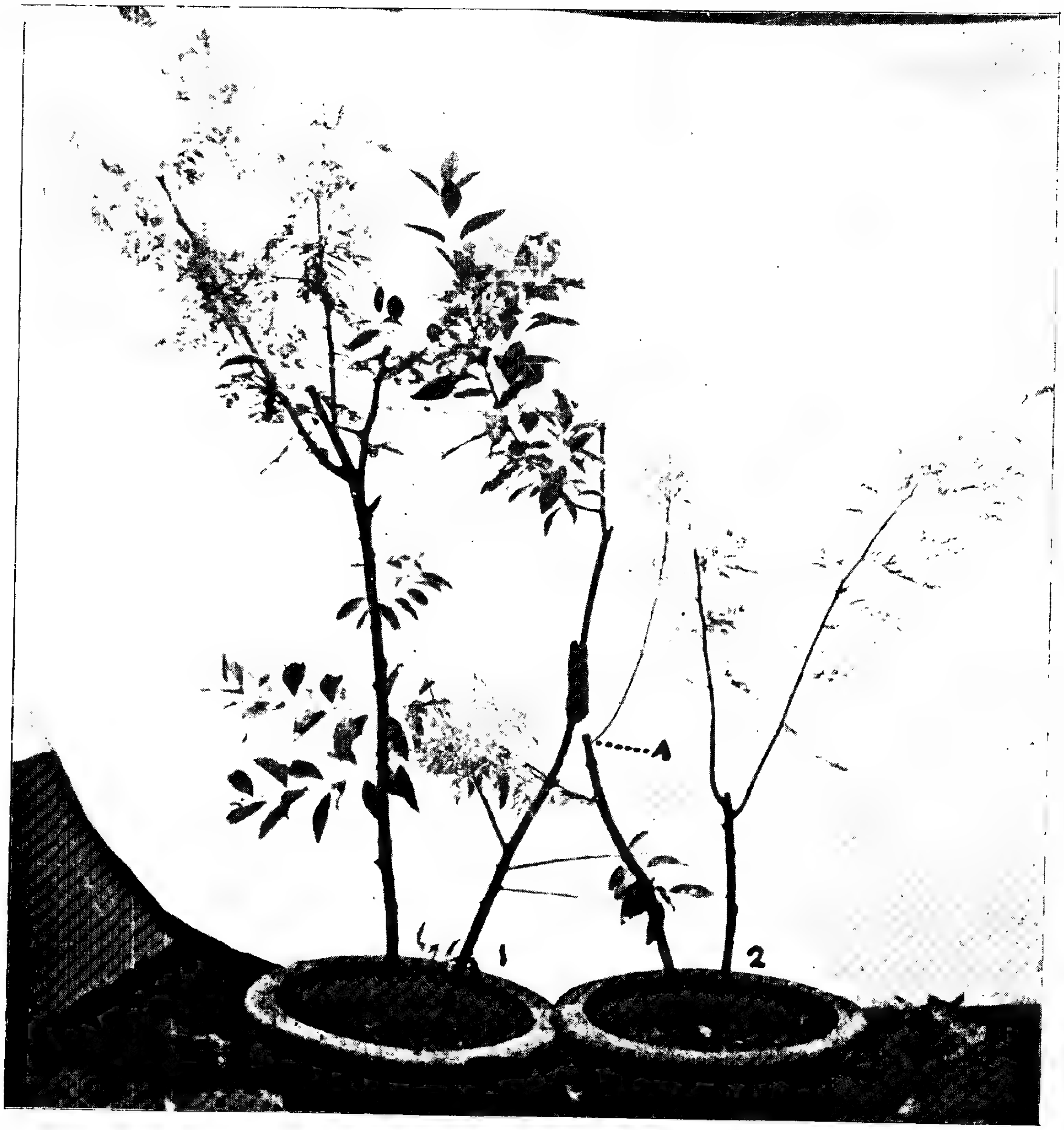
(1) *The tissues through which the virus travels.*

It is now well-known that patches of bark stripped off the spiked sandal and grafted on to healthy plants produce the disease in the latter. It is, therefore, obvious that the infective virus is found in and travels through some of the tissues of the bark comprising the phloem elements and the cortical parenchyma. It has not yet been definitely established, whether the infective agent travels or not through the xylem elements as well and the point is discussed in this paper.

In some of the virus diseases of other plants, it has been established that the infective agent does not travel through xylem tissues. Bennett (1) showed that the curl virus of raspberries cannot travel through 'ringed' stems, and that a small amount of bark bridging the 'ring' is sufficient to permit the passage of the virus. Caldwell (2) experimenting on 'aucuba' mosaic of tomatoes, killed the living cells in a portion of the stem of tomato plants by either chloroform or steam and found that the virus did not travel across this bridge of dead tissue, though water from the roots passed through this region.

In our experiments with spike disease of sandal the method of ringing was adopted, but as the minimum incubation period is very long, extending from 2 to 3 months, a way had to be devised to keep the plant above the ringed portion alive for a long time. Ordinarily the ringed branches of sandal keep alive from 2½ to 4 months, depending on the season of the year after which the leaves above the ringed portions start wilting. This period itself is just enough to ascertain if the disease can cross the ring, provided the incubation period is at its minimum.

The following device was evolved to keep the ringed portion of the plant alive for a long period. A potted sandal was inoculated with a spiked bud graft of the Rosette type, half way up the stem, and just above this graft the stem was ringed to a distance of one inch by stripping off the bark all round. The stem above the ring was then approach-grafted to a healthy sandal in another pot, as



Shows that spike virus cannot pass through ringed stems. Sandal plant (2) inoculated by budding at point A and ringed above. The upper part of the stem, above the ring, grafted to a healthy sandal. (1) Sandal plant; (2) below the ring, fully spiked and above the ring quite healthy and vigorous. Both sandal have the same *Acacia* host.

shown in the pictures on Plate 16. A month after inoculation the grafted bud produced spiked shoots and the disease appeared on the stock below the ring in 3 months. But the infection started spreading only on the portion of the stem below the ring, and in six months all stock below the girdle was diseased. The picture in the plate noted above was taken 11 months after inoculation, and it is seen that while the entire stem below the ring is fully spiked, the portion above is perfectly healthy and growing quite normally. Two experiments conducted in this way have yielded identical results. It is therefore obvious that the disease is unable to cross the ring, as the virus apparently does not pass through the xylem tissues.

(2) *The rate of movement of the Spike virus in sandal plants.*

In discussing the rate of movement of the virus in infected plants, its spread in two directions has to be considered, (1) in a vertical direction up and down from the point of inoculation, (2) in a lateral direction, round or across the stem. In spike disease of sandal, the movement in the vertical direction has been found to be more free than in the lateral direction. In this paper the movement in the vertical direction only is discussed.

Attempts have been made to work out the rate of movement of the infective agent in the case of some other virus diseases. Severin (11) found that the virus of curly top of sugar beet moved at the rate of 4 inches per hour in his experiments. McCubbin and Smith (7) calculated that tomato mosaic travelled 8 to 18 inches in 10 to 20 days. Caldwell (2) summarising the literature on the subject, states that in tomato stem it has been found that the 'mosaic' travelled a distance of 12 to 25 centimeters in 3 to 5 days and 'streak' a similar distance in 4 to 7 days. In tobacco leaf, the virus of mosaic travelled a distance of 13 cms. in a minimal period of 2 days. For the same disease in the same host there has been a certain amount of variation in the results obtained.

In spike disease of sandal, with its long incubation period, the infection travels much more slowly than in the cases of Annuals noted above. In the experiment conducted by us to ascertain the rate of

movement of spike disease a large number of sandal saplings 2 to 3 years old growing in beds in Central Nursery, Bangalore, were inoculated by budding during June and July 1932, and only those cases were selected where the grafted buds sprouted and sent out spiked shoots. The strain of disease used in inoculation was of the Rosette type. The plants were either ringed or cut off at different distances below the spiked graft, to ascertain the distance the virus had travelled down the stem during the period from the date of inoculation.

The following table gives the details of the experiment.

S. No.	Interval between inoculation and ringing or cutting off, of stem.	Distance down the stem from the inoculated region, ringed or cut off.	Resulting condition of the plant.
1	96 days ..	1″ below ringed ..	Spiked.
2	do. ..	2″ do. ..	do.
3	do. ..	3″ do. ..	Healthy.
4	do. ..	3½″ do. ..	Spiked.
5	do. ..	4″ do. ..	do.
6	do. ..	4″ do. ..	do.
7	do. ..	5″ ..	Died without showing the disease.
8	do. ..	6″ do. ..	Healthy
9	do. ..	6″ do. ..	Healthy.
10	do. ..	8″ do. ..	Died without showing the disease.
11	do. ..	10″ do. ..	Spiked.
12	115 days ..	11″ below cut off ..	Spiked.
13	172 days ..	11″ do. ..	Healthy.
14	169 days ..	11½″ do. ..	Spiked.
15	170 days ..	12″ do. ..	Spiked.
16	170 days ..	12″ do. ..	Died without showing the disease.
17	89 days ..	12″ do. ..	Spiked.
18	89 days ..	15″ do. ..	Healthy.
19	116 days ..	15″ do. ..	Spiked.
20	116 days ..	18″ do. ..	Spiked.
21	do. ..	22″ do. ..	Spiked.
22	166 days ..	22″ do. ..	Healthy.
23	do. ..	22″ do. ..	Died without showing the disease.
24	do. ..	22″ do. ..	Spiked.
25	78 days ..	22″ do. ..	Healthy.
26	116 days ..	23″ do. ..	Spiked.

In the experiment, 4 out of 26 plants operated died without manifesting the external symptoms of the disease. It has to be considered that they succumbed to the disease as ringing or pollarding of healthy saplings do not kill them. In 96 days after inoculation, while in one case the infective agent had not travelled 3 inches, in some others it had moved down different distances up to over 10

inches. In the experiment the quickest rate of movement of infective agent has been over 12 inches in 89 days and over 23 inches in 116 days. The slowest rate was found in plant No. 13 where the infective virus had not travelled 11 inches in 172 days.

The rate of spread of the virus apparently is not at all uniform in all plants but varies considerably. It may partly be due to differences in the vitality in individual plants and the degree of resistance to the disease offered by them.

The movement of the virus down the stem and then up into an infected fork is always much slower than in only one vertical direction. We have observed several cases where sandal trees forking near ground level have been inoculated on the limb of the fork and though the disease spreads over that entire limb in 6 to 9 months, it takes 1 to $1\frac{1}{2}$ years to manifest itself on the other limb, and when the tree dies, sometimes the spike will not have appeared on all the branches in the latter.

Summary.

Two strains of spike disease of sandal are differentiated. The strain commonly found is designated as the Rosette type, and the new strain ascertained as the Pendulous type.

The symptom complex of the Rosette type consists of short stiff branchlets, clusters of shoots very small, narrow stiff leaves, entire absence of flowering, rapid death of root ends and haustoria.

The Pendulous type shows drooping long leaf bearing twigs, absence of clusters of shoots, larger and conspicuously broader leaf blades, occasional sparse flowering, and very slow death of haustoria and root ends.

When these two types are combined in the same plant, the symptoms assume an intermediate character.

It was ascertained that the infective agent does not pass through ringed stems, and hence it is obvious that the virus does not travel

through xylem tissues, but through some of the cells comprising the phlœm and the cortical parenchyma.

Attempts to ascertain the rate of movement of the infective agent through inoculated plants revealed considerable variations, due probably to differences in vitality and disease resistance powers between the individual plants operated upon. In the experiments conducted, the quickest movement has been over 12 inches in 89 days after inoculation, while in the slowest the virus had not travelled 11 inches in 172 days.

December 30th, 1933.

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REVIEWS

Annual Report on Working Plans, Silviculture and Entomology in Burma for the year 1932-33.

In para 6 of this report, we read that " owing to financial stringency, all working plans field work has been temporarily postponed. This is regrettable as not only does it entail arrears in the preparation of working plans but also the disorganization of the highly trained working parties. The postponement is unfortunately unavoidable

in view of the state of the provincial revenues." Further, from para 11 (p. 67), we learn that the Forest Zoologist's staff has been at a "maintenance minimum" with which it was just possible to carry on, but impossible to undertake any new investigation, and we believe the Zoologist himself also had charge of a division. Finally, it is recorded that three different officers held the post of Silviculturist during the year. With these handicaps, there would be very good excuse for a poor showing, but the report is full of "good meat" so much so that it is impossible to do more than select a few titbits likely to be particularly interesting to foresters outside Burma, and make just one or two comments.

During its 12 years of activity the Working Plans Circle has increased the area under sanctioned working plans from 10,855 square miles to 26,347, and the area for which plans are still required now stands at 1,350 square miles. Deviations from prescriptions are many of them due to the regularisation of the removal of matchwood timbers. Teak girdlings have dropped to half the usual figure owing to the slump, but the area of new plantations (3,165 acres) is but little under the average of the last five years. The Mingalun Tidal reserve was stockmapped from the air by Mr. Scott with very useful results.

"In view of theft, continued protection is considered waste of money and the areas (in Prome division) are to be proposed for disforestation." (p. 23). This precedent may be all very well in richly forested Burma, but we hope it will not be followed elsewhere.

In two places (pp. 26 and 42, paras. 18 and 69), we note references to the need of further attention by the research officer to divisional experiments, which the divisional staff either lacks time or experience to deal with adequately, the result being the loss of valuable information which might have been obtained, and of the time given to the initiation of such experiments. This confirms experience in every province of India.

"There is certainly no room now for a planting centre which does not regularly show 90% and over of strong plants at the end

of the first rains " (para. 34). This extract is aimed at no one in particular, but the consciences of some responsible for plantations may be stirred. The stump planting method for teak is finding further application and is being further studied, transplanting or direct sowing continuing to be practised in many divisions on various grounds. The economy of stock associated with the use of stumps is referred to (para. 30) in connection with the growing realisation of the need for seed selection for plantation work. The seed origin investigation is reported on in para. 112, the excellent early results with Travancore seed standing out conspicuously. " Special efforts were made this year in Insein to get seed collection from good seed-bearers only " (para 44). It is noted that we have far to go yet in this matter.

" Much of the work......which is now being put into plantations of 6 or 7 years and upwards is a legacy from original mistakes......" ——— -a platitude, perhaps, but one which can hardly be dished up too often, when the length and breadth of India is still so liberally besprinkled with examples of the results of disregarding it. The point is stressed in the course of a survey of the possibility of cutting down formation costs.

" Spacings wider than 6′ × 6′ for teak have been tried previously and found wanting." (Arakan, para. 71). At the same time variations such as 9′ × 1′ and 12′ × 3′ are again being studied in relation to weeding and thinning costs.

With regard to mixtures of species in plantations, it is recorded that old plantations where teak and *Acacia catechu* were planted together are usually good, the soil improving qualities of the latter species having been remarked on before (para. 39); the double stocking with teak with *pyingado* in quincunx was continued generally in Insein division.

The further references to the use of guava bushes in *taungya* plantations in Insein (para. 38) are interesting, as also are the paragraphs on soil research undertaken or contemplated (para. 77), and as these provide a more cheerful note on which to conclude than the comments on the position as regards fire protection in Tharrawaddy and Zigon (para. 83), we will only refer the reader to the latter but will not reproduce them.

H. G. C.

A SKETCH OF THE GEOGRAPHY AND GEOLOGY OF THE HIMALAYA MOUNTAINS AND TIBET

BY COL. S. G. BURRARD, R.E., F.R.S., SUPERINTENDENT, TRIGONOMETRICAL SURVEYS, AND H. H. HAYDEN, B.A., F.G.S., (LATER SIR HENRY HAYDEN, K.T. C.S.I. C.I.E.) SUPERINTENDENT, GEOLOGICAL SURVEY OF INDIA, REVISED BY COL. SIR SIDNEY BURRARD, K.C.S.I., F.R.S., AND A. M. HERON, D.S.C., F.G.S., F.R.G.S., F.R.S.E., SUPERINTENDENT, GEOLOGICAL SURVEY OF INDIA. EDITION OF 1933.

Parts I and II have been published with all the authority of distinguished members of the Trigonometrical and Geological Surveys of the Government of India, and the contents fully justify the republication and amplification of the edition of 1907, which for a quarter of a century has been of the greatest value to those interested in the Himalayas. The volumes are intended to cater for the general public as well as for those specially interested in scientific research and are eminently readable. Parts I and II have attained a high standard of excellence and Parts III and IV will be awaited with great interest.

Part I " The High Peaks of Asia " opens with a diagram of the mountain chains from the Siwaliks in the south at latitude 28° to the Tien Shan, " The Celestial mountain " in the north at latitude 44°, and shows the trend of the ranges which stretch across the whole of the country to the north of India and comprise the catchments of all the great rivers of Asia.

Many of us have visited some at least of the Himalayan hill stations and have gazed from afar at impressive snowy peaks ; some of us have worked in portions of the outer Himalayas ; the duties of only a very few have taken them to the forests clustered on the slopes of the great Himalayan range, but to none of us is vouchsafed the detailed knowledge of more than a fraction of the extensive area covered by these mountains.

The writer of this review can claim acquaintance only with the Punjab Himalaya in which he has worked for many years : he has seen from afar the Kumaon and Nepal Himalaya and feels diffident when attempting to review a publication of this nature. Part I gives tables of the peaks of great altitude and diagrams illustrate their

distribution. A whole chapter is devoted to nomenclature, and it is in this respect that the traveller finds great difficulty in identifying peaks as they generally have no local names unless they have religious significance. The way in which geographical discoveries of first rate importance are obscured by controversies over nomenclature is illustrated by Sven Hedin's great discovery of the Trans-Himalayas in 1908. "Sven Hedin's explorations had been so arduous and so important that they deserved cordial and generous recognition, but public opinion in India took exception to the name Trans-Himalayas." It is satisfactory now to learn that "The Survey of India has thus been led to recognise the force of Sven Hedin's arguments, and to accept the name Trans-Himalayas which he introduced." The evolution of geographical names in the Himalaya is described in detail for the great peaks and ranges and a history is given of the explorations and surveys which have placed them on the map. Chapter 5 gives a brief record of the causes which have rendered difficult the fixation of their heights.

Part II. "The principal mountain ranges of Asia" opens with a chapter on the origin of mountain ranges and discusses in detail the various theories which have been put forward from time to time. "The floor of a former Tibetan sea has been raised and wrinkled" as our American friends would say "Some wrinkles"! The opening paragraphs are quoted below :—

The floor of a former Tibetan sea has been raised and wrinkled.—The surface of Central Asia appears to consist of two primary elevations of the crust, separated by a trough-like depression ; the southern elevation is the plateau of Tibet, the northern is the Tien Shan chain, the intervening depression is the Tarim basin. A second trough is to be seen south of the Tibet plateau separating that plateau from the ancient Vindhya mountains ; it is now filled with alluvium, and constitutes the plains of Northern India.

These two wide elevations of the crust and their complementary depressions form the basis of the mountains of Asia.

Until a comparatively recent date in the geological time-scale the middle tertiary epoch—all the northern part of what is now the

Himalaya, and probably the whole of Tibet were covered by a great sea (named by Suess " Tethys ") in which deposition of sediment had continued for a vast period. At length, owing to forces the origin of which we can at present only conjecture, a period of crust-movement set in and the floor of the Tibetan sea began gradually to rise and to be thrown into a series of long parallel wavelike folds.

As the crests of the earth-waves rose from the waters of the sea, they were eroded by rain and weather, and the rising land became broken and irregular; drainage basins were carved out of its flanks and a river system, composed of " transverse " valleys was gradually developed. As elevation continued, the troughs of the folds emerged and a series of " longitudinal " valleys was established at right angles to the transverse valleys and parallel to the longitudinal axes of the folds. From a combination of the concurrent processes of elevation and erosion, the existing mountain systems of the Himalaya and Tibet have been slowly evolved. As denudation has proceeded, deeper and deeper parts of the crust have been laid bare, but the forms of many folds can still be traced and the trends of their longitudinal axes followed for long distances. The folds, although analogous to waves, more nearly resemble the breakers on a beach than the swell of the open sea; the form of their surface is rarely that of a simple arch and trough; fold has been superimposed on fold, arches have been overturned until they are almost horizontal, and whole areas have been so distorted and crumpled that the details of structure can only be unravelled with difficulty. Where the stress has exceeded the breaking strain of rock, the structure has been complicated by fracture; parts of the crust have in some cases subsided, and in others been moved horizontally. Nor are these the only causes of complexity, for along many of the planes of weakness and fracture molten material has been forced up from below, and has partly absorbed the original sediments."

I shall now conclude this review by recommending all interested in the Himalaya to purchase these volumes: every Circle or Divisional library in the North of India ought to possess copies which are

obtainable at the office of the Geodetic Branch, Survey of India, Dehra Dun.

H. M. G.

EXTRACTS

SUMMARY IN NARRATIVE FORM OF GORAKHPUR WORKING PLAN 1934-35 to 1948-49.

BY R. O. DRUMMOND, WORKING PLAN OFFICER, GORAKHPUR FOREST DIVISION.

Working Circle I (Sal).

1. To this working circle have been allotted all the sal forests situated close to markets, where the demand is for small poles and fuel, and where the produce will all be absorbed locally.

Silvicultural system will be clear felling with immediate regeneration mostly natural from coppice, supplemented by artificial regeneration on the *taungya* system, where natural regeneration fails. The rotation will be short, to supply the demand for large quantities of small poles and fuel.

The area of this Working Circle is 10,780 acres.

2. The working circle is composed of exactly the same area as W. C. I. of the 1924-34 plan. The rotation has been increased from 40 to 50 years to allow for coppice failures and slower growth of *taungya* grown sal.

20 coupes have already been clearfelled and these remain the same. The remaining area of old forest has been divided up into 30 new coupes shown on the management and working plan maps.

Coppice failures are to be put under *taungya*, preferably with sal, instead of planting up with teak, as laid down in the 1924-34 plan. Teak planting will only be done where *taungya* cannot be arranged, and in small coppice failures, larger than 1 10 acre but too small for introducing *taungya*.

Standards will not be retained, as prescribed in the last plan, as they are of no avail as protection against frost.

Working Circle II (Sal).

3. This working circle comprises the larger areas at a short distance from markets, where the produce is mostly absorbed locally, but there is a surplus for export and therefore the rotation has to be slightly longer to allow production of larger poles for export.

The silvicultural system is clearfelling with regeneration mainly artificial by *taungya*. Wherever good coppice is obtainable over a sufficient area, this should be taken advantage of, and not be put under *taungya*, as coppice regeneration is preferable to *taungya*.

The area of this Working Circle is 18,319 acres.

4. The area is the same as that allotted to W. C. II of the 1924-34 plan. The rotation has been increased from 50 to 60 years to allow for slower growth of *taungya* grown sal. There is practically no other change from the prescriptions of the

last plan except that *taungya* is now definitely established and is to be taken advantage of wherever coppice fails, except in small blanks in coppice of 1/10 acre or more, but too small for *taungya*, which will be planted up with teak.

Working Circle III (Sal)

5. To this working circle are allotted all the sal areas of the northern forests, where the distance from markets is great and a rotation sufficiently long to allow the production of small timber for sawing was necessary.

The silvicultural system is that of clearfelling with regeneration both naturally from coppice and artificially by *taungya*, but mainly the former.

Four felling series have been made on a basis of ranges to simplify management and also to provide for small local markets.

The area of this Working Circle is 46,976 acres.

6. The area and allottment to felling series is the same as in the last plan. The rotation has been reduced to 75 years as the demand for poles has permanently increased and so lowered the financial rotation. At the same time lowering of the rotation will to some extent balance the drop in revenue due to increased rotations in W. C.'s I and II, and to reduction of areas of old forest to be thinned, being replaced by unsaleable thinnings in young coppice crops.

Areas where coppice will succeed, and areas where coppice will fail, have been separated in each felling series throughout the working circle and the correct proportion of each will be clearfelled annually. This was not done in the 1924-34 plan.

Where coppice will fail, regeneration by *taungya* is prescribed. Only small failures of 1/10 acre or more, but too small for *taungya* to be introduced will be planted up with teak, in areas where, as a whole, the new crop will be of coppice origin.

This change was foreseen in the 1924-34 plan and can now be adopted as *taungya* has become possible.

Working Circle IV (Miscellaneous).

7. This working circle contains all the areas of good, dense miscellaneous forests of the northern forests.

The system prescribed is that of clearfelling with artificial regeneration preferably by *taungya* of the most valuable species suited to the area such as *khair*, teak, *shisham*, *jamun* etc

The rotation is fairly short to suit the quick growth of those valuable miscellaneous species.

The area of this working circle is 4,671 acres.

8. This is a continuation of the prescriptions of the last plan, with the substitution of artificial regeneration by *taungya* instead of by departmental plantation, when and where possible.

Working Circle V (Grass).

9. All the grass areas of the northern forests are allotted to this Working Circle. Three-monthly, six-monthly and twelve monthly periods for grazing are allowed

and each grass compartment is allotted to one of these so as to provide both grazing and the production of thatching grass in the best areas.

The area of this working circle is 31,017 acres.

10. This is a continuation of the prescriptions of the last plan, without change.

Working Circle VI (Jamun).

11. All the best *jamun* belts of the division are allotted to this working circle.

The system is that of clearfelling with regeneration by coppice and natural seedlings, felling a certain length of each belt each year, corresponding to a rotation of 40 years. The total length of belts allotted to this working circle is 61 miles and 60 chains.

12. This is a continuation of prescriptions of last plan, with the addition of another two felling series, conclude the *jamun* belts of the northern forests which are now economically exploitable.

INSECT TRANSMISSION OF SPIKE DISEASE

It has been recently announced[1] that transmission experiments with the Jassid, *Moonia albimaculata*, have yielded three positive results: that the symptoms so produced are inseparable from typically spiked plants on morphological, biochemical and cytological grounds.

This important result was the subject of a discussion at one of the meetings of the Working Committee on Spike Disease Investigation (July 28, 1933) when Dr. V. Subrahmanyan, in view of the fundamental nature of the finding, suggested that the result should be critically examined in all its aspects. As a result of the discussion, it was felt that the evidence, based on symptomatic and other grounds, was by itself not sufficiently conclusive to justify the incrimination of *Moonia* as the vector of spike disease. It was therefore suggested that the matter should be regarded as *sub judice* pending the results of infectivity experiments by grafting, which was considered to be the decisive test in doubtful cases of disease.

It is well known that the sandal plant assumes a variety of morphological characteristics, some of which are often mistaken for the condition of spike. Experiments have shown that this condition can be brought on by deprival of host plants, an impoverished soil, drought and other adverse soil and climatic factors. These symptoms can be distinguished from those of a genuinely spiked plant, are not transmitted to other healthy plants by grafting and can be made to disappear when the adverse conditions are removed.

A typical spiked plant, however, is infective, the symptom of the disease being communicable to other healthy plants through grafting, a technique which has proved most useful in determining the infectivity of doubtful cases of spike. It is the infectious character of the disease that renders the problem economically important and serious.

1. *Nature*, 132, 592, *October*, 1933.

It is clear from the above discussion that it is important to distinguish between the curable and non-infectious condition of stunting induced by an adverse environment, as against the deadly and infectious condition of spike disease, which, to an experienced worker, is not difficult to diagnose. The following are results of grafting tests which have been carried out :—

Leaves from		Number of plants operated.	Number of plants spiked.
Spiked plants	..	12	9
Insectary plants	..	14	0

They confirm the suspicion that the three plants alleged to be diseased only represented a stunted condition which was brought on by an impoverished soil, want of a vigorous host and probably aggravated by insect feeding. The symptoms have not been transmitted through grafting, and further, the plants themselves, after a careful nursing with fresh soil and host, have since turned completely healthy.

By M. Sreenivasaya, Department of Biochemistry, Indian Institute of Science, Bangalore, January 18, 1934, *Nature*, 133, No. 3358, March 10 1934.

Mr. M. Sreenivasaya's note on this subject creates an impression that does not appear to be justified by accomplishment. Of 12 healthy sandal plants grafted with leaves from typically spiked plants, 9 became infected, while 14 similar plants grafted with leaves from *Moonia*-infected plants remained healthy. Moreover, the *Moonia* infected plants, after '*careful nursing with fresh soil and host, have since turned* completely healthy.'

This is the extent of the accomplishment on which Mr. Sreenivasaya bases his criticism, and I do not think it can be accepted by any critical worker in the absence of details and information on influencing factors. Mr. Sreenivasaya has omitted to state, for example, that the *Moonia*-infected plants had been repeatedly pruned at short intervals, while the spiked plants providing the grafts had only been pruned once after infection, and represented a highly virulent type of the disease. Obviously this is a very important influencing factor. I should add that, in the case of grafts *from Moonia-infected plants, organic fusion of the grafts did not take place. I am* informed that grafts from healthy to healthy plants behave similarly, but I cannot help feeling that further evidence on this point and a series of control experiments would have strengthened Mr. Sreenivasaya's argument. As it is his small and not very comparable series of experiments (assessed as they are on a type of evidence which is considered inconclusive when applied to the results of insect transmission studies) cannot be regarded as decisive.

Regarding the plants which have become 'completely healthy' I was able to see them at the time when Mr. Sreenivasaya wrote his note, but could not concur with

[1] Nature, 133, 3358, March 10, 1934.

his opinion. I have seen healthier looking plants that are regarded as 'genuinely spiked', and I also know that the spike-like faces of diseased sandal plants can be markedly reduced by pruning and similar nursing or even by growing in the shade. But if Mr. Sreenivasaya has really succeeded in curing the *Moonia*-infected plants he can record a positive achievement. I am, however, unable to relate it to his argument. Virus diseases are not regarded as incurable, and I believe at least two authentically spiked plants have recovered.

Finally, it is obvious to any reader of the announcement [2], which prompted Mr Sreenivasaya's letter (and Mr. Sreenivasaya and his colleagues have had access to more elaborate information), that his theory of 'stunting induced by an adverse environment' has little support, since hundreds of transmission experiments were carried out with plants comparable as to age, host plant, and environmental conditions. I should add that, as his criticism concerns results for which I am essentially responsible, I have myself never regarded them as more than justification for further investigation through extensive transmission and ecological studies. Progress in this direction would be more profitable than the deliberations of mixed committees wishing to adopt an attitude of scientific scepticism which would be commendable if it were necessary, or experiments that are pointless at present even if they can be regarded as conclusive.

By Cedric Dover, F. R. I., Dehra Dun.

FOREST INFLUENCES—STREAMFLOW AND EROSION

The major purpose of the streamflow and erosion project is to determine the comparative efficiency of different types of vegetative cover for watershed protection in the Southern Appalachian region. This purpose is being carried out through two closely related lines of investigation. The first involve plot studies of the comparative efficiency of certain types of vegetative cover (or its absence as in the case of eroding fields) in influencing absorption and percolation and in protecting the soil from erosion. A second line of investigation is an extensive study of the organic layers of the soil profile (humus type) as influenced by the vegetation type, coupled with an examination of the effectiveness of different humus types in governing absorption and percolation of precipitation and in protecting the soil from erosion.

Beginning with July 1, 1932, continuous records have been made of the amount of stormflow following each storm from 10 permanent plots on the Bent Creek Forest. From these plots, representing five common cover types, stormflow was measured as surface run off and also as subsurface flow at 12 inches. These continuous records are the first of their kind ever obtained in the Southern Appalachian Mountains These records and others will serve as a basis for interpreting the movement of stormflow from representative cover types within the region.

The usefulness of the records will increase with the continuation of observation. 66 rain storms and 2 snow storms occurred during the 12 months period ending June 30, 1933. A summary of the nature of these storms, together with a record of stormflow, is shown in accompanying tables (1 and 2) :—

[2] Nature, 132,592, Oct. 14, 1933.

TABLE I.

Surface run off of different types of forest cover from 30 storms classified as to total precipitation and maximum intensity. Period July 1st, 1932 to January 1st, 1933

Storm class precipitation in hundreths of inches.	Storm class. Maximum intensity range 20 minutes period.	Number of storms.	Average total precipitation per storm, inches.	Average maximum intensity per storm, 20 minutes period.	Total duration. H. M.	Average percent surface run off. Plots 1E and 2 W. (white oak, black oak, scarlet oak).	Average % surface run off. Plots 3 N and 4S. old field pine 25 years old.	Average % surface run off. Plot 5E & 6W. Raked yellow pine hardwood.	Average % surface run off. Plots 7E & 8 W (Control 5 E & 6W.) Yellow pine-hardwood.	Average % surface run off. Plot 9 N. old-field restocking pine.	Average surface run off. Plot 10 S old-field grass covered.
25—less ..	·01—·10	2	·18	·09	1—20	1·28	·19	1·31	·38	·25	·18
25—less ..	·11—·20	1	·22	·14	1—00	·22	·02	10·23	·10	·00	·00
26—50 ..	·01—·10	7	·36	·05	7—30	3·86	·06	1·78	1·80	·04	·04
26—50 ..	·11—·20	2	·40	·14	2—20	4·18	·44	6·39	2·40	1·72	1·55
51—100 ..	·01—·10	7	·75	·08	13—43	4·63	·22	2·61	1·97	·79	2·16
51—100 ..	·11—·20	2	·67	·16	3—45	4·20	·48	16·24	2·79	1·31	2 09
51—100 ..	·21—·50	3	·85	·38	2—20	2·75	·56	22·31	2·81	1·39	2·26
101—over ..	·01—·10	2	1·23	·08	13—00	3·76	2·53	5 01	·45	·68	·59
101—over ..	·11—·20	4	1·69	·14	13—33	5·42	1·02	10·06	·72	2·02	1·14

TABLE II.

Surface run off of different types of forest cover from 36 storms. Classified as to total precipitation and maximum intensity.

Period January 1st, 1933 to June 30th, 1933. Bent Creek Experimental Forest.

					H. M.						
25—less ..	·01—·10	13	·11	·047	1—35	·558	·042	1·119	·813	·099	·13
26—50 ..	·01—·10	3	·34	·06	5—40	3·18	·02	2·13	2·07	·35	·04
26—50 ..	·11—·20	3	·41	·14	3—33	2·81	·09	·91	2·41	·59	1·08
26—50	·21—·50	1	·26	..	0—10	2·06	·16	45·22	2·30	0	0
50—100 ..	·01—·10	4	·76	·07	14—37	4·62	·13	2·52	2·46	·84	3·23
50—100 ..	·11—·20	6	·69	·16	3—19	3·26	·42	16·66	2·73	1·09	0·75
50—100 ..	·21—·50	2	·59	·36	0—50	3·46	·58	26·69	3·04	0·50	5·01
101—over ..	·11—·20	1	1·09	·19	7—0	4·38	·62	22·39	3·74	1·13	0·72
101—over ..	·21—over	3	1·71	·68	11—20	3·78	1.03	23·94	3·21	5·49	7·22

It is apparent from these data that old-field pine stands (Plots 3, 4 & 9) control excessive run off of precipitation, and that whenever fields abandoned for agriculture present a serious erosion and flood menace the establishment of pine on such land offers a practicable control of these evils. Also it is demonstrated that natural grass cover, such as broomsedge (plot 10) is effective in controlling both erosion and excessive surface stormflow on the areas under observation.

By far the greatest amount of surface run off comes from the oak-pine area (plots 5 & 6) from which the litter has been removed for the past three seasons. Here the surface run off amounted to from 10 to 20 times that of adjacent undisturbed areas used as controls (plots 7 & 8). These results afford ample evidence that wherever the litter of the forest floor has been removed either by fire or for use as bedding or other purposes, the amount of surface run off will be greatly increased and may lead to a serious erosion and flood menace.

Observations of surface runoff from an experimentally burned oak-chestnut area as compared with an adjacent unburned control area showed a considerable increase in run off brought about by the burning. Particularly was this evident on areas of 40 per cent or more slope.

The observations to date on the runoff from the 10 original plots under investigation are valuable not alone for the comparative data for different vegetative cover types which have been obtained, but the study has also served to orient the problem and to develop desirable field methods and plot procedure. Experimental technique has been developed permitting the study of water absorption and stormflow induced by artificially supplied precipitation to small areas in site under natural vegetative cover types. This procedure has proved to be satisfactory and furnished a promising method of obtaining further data pertinent to forest and water relations.

In all 26 plots have been established on the Bent Creek experimental forest for continuous observation of stormflow following each storm. These plots are grouped as follows: -

Burned areas as compared with unburned areas in oak-chestnut type	..8 plots.
Raked areas from which litter has been removed annually as compared with undisturbed areas in yellow pine-hardwood type	..6 plots.
Old-field stands as compared with pasture without tree cover	..4 plots.
Uniformity tests of equal areas, yellow pine-hardwood type	..8 plots.

Progress has been made in expanding knowledge of the humus types within the Southern Appalachian Region through a study of organic layers of the soil profile of the run off plots at the time of installation. The final objective of this study is a field classification of humus types, based primarily on observation of the soil profile together with a knowledge of the characteristics of the soil horizons. To obtain this information characteristic humus types are to be compared on the basis of significant laboratory analysis with particular reference to physical structure as related to absorption and percolation of water to organic content, and to microbiological activities.

A project progress report giving complete table of records, graphs and charts is in preparation.

1933 *Plans.*—Plans for the coming year include continued observation of run off from all the permanently installed erosion and run off plots. They also include observations from larger areas than are possible under plot methods. Use will be made of dams with V-notched wiers and water-level recorders so installed as to measure the stormflow from small areas constituting miniature watersheds. Continuous precipitation intensity records will be kept. In addition it is planned to follow out a field study of absorption and porosity of different humus types, using a special apparatus designed to furnish actual time in seconds required for a given humus type to absorb a given number of inches of water under controlled conditions.

It is also planned to extend the study of humus types to include observations on vegetation problems, associated with the rehabilitation of denuded and eroded lands. The object in view in this latter study is to increase information as to intermediate and minor vegetative cover types in the re-establishment of forest cover on bare and denuded lands.

(*12th Annual Report for* 1932 *and Program—Appalachian Forest Experiment Station*).

CONSERVATION OF TROPICAL FORESTS

Three articles which have appeared in the *Empire Forestry Journal* (Vol. 12, No. 1, 1933) display the difficulties which exist in conserving and putting to their fullest utilisation the tropical forests of the Empire. To take the second case first, Sir Ralph Pearson, formerly Director of the Forest Products Laboratory at Princes Bisborough, discusses the problem of creating and developing markets for Empire hardwood timbers at home.

Sir Ralph briefly reviews the reasons why well-known timbers have not found favour amongst markets in great Britain, ascribing some of the causes to the fact that the consignments sent over were often not carefully chosen ; nor, with the facilities available in the forests, was there much chance of their being so chosen when the short-handed and overworked forest officer was himself responsible for their despatch. Sir Ralph deprecates trying to push too many new timbers upon the markets at the same time, and points out the way in which chosen timbers should be forwarded and tested.

A second article, by Mr. J. B. Clements, Conservator of Forests in Nyasaland, treats of the cultivation of finger millet (*Eleusine coracana*) and its relation to shifting cultivation in Nyasaland. This article, and the practice dealt with, is typical of one of the chief sources of the disappearance of valuable forests in tropical countries, the difficulties facing the administration, not always convinced of the increasing injury supervening, in weaning the people from so wasteful a form of primitive agriculture ; and finally, of the troubles of a forestry department well aware of the evils resulting from the practice.

" It is therefore clear that shifting cultivation in Nyasaland is accelerated to a very considerable extent by the growing of *Eleusine coracana* under prevalent methods.

Compared with the growing of other crops, the requisites of the millet make extravagant demands as regards the use of land, and systematic burning of the top soil combined with flat cultivation when carried out on any large scale leads to widespread loss and impoverishment of the soil, particularly in the hilly country. Rapid deforestation inevitably takes place in any wooded country where the millet is grown, as conditions there are ideal for providing both new soil for each crop and fuel for heating the soil."

The third article, by N. V. Brasnett, Conservator of Forests, Uganda, discusses the formation of State forests, and forest rights and privileges of local inhabitants in Uganda. After briefly reviewing the position of the colony from the day, in 1890, when Captain (now Lord) Lugard signed a treaty on behalf of the British East Africa Co., with the king of Buganda, the declaration of the British Protectorate in 1894, and Sir Harry Johnston's arrival in 1899 and subsequent organisation of the administration of the country, the author concentrates upon the various arrangements, regulations and ordinances for the management of the forest areas of the country.

It is impossible to deal with the varying policies to which succeeding administrations subjected the forests after the first and promising lines were laid down. But a perusal furnishes evidence that one of the past flaws in colonial administration has been the refusal or inability of those responsible for the future welfare of their charges to lay down a definite forest policy, based on wide views, and to adhere to it.

Mr. Brasnett ends his summary of the present position of the forests in Uganda with the sentence :—" When formation is completed it is estimated that the State forests of Uganda will constitute just about 2 per cent. of the total land area of the Protectorate, and the total forest area, including private woodlands and the valuable savannah, just over 3 per cent, so that it is obviously essential to preserve the whole of this small percentage." Many conversant with the tropical forest and the importance it plays in countries where it exists would consider the percentage dangerously low. (*Nature, 21st April* 1934).

THE IMPORTANCE OF LITTER IN FOREST SOILS

A question frequently discussed in forestry is whether it pays to remove from the soil the annual fall of litter and sell it, or to leave it to decompose and fertilise the forest with the mineral matter it contains. The forest owner is often in favour of removing the litter; his object is to obtain a permanent money yield from the forest, and to him the litter is as much a marketable product as the timber, which he will certainly remove from the forest as it matures. He admits that soil impoverishment may become apparent in the next generation, but meanwhile the whole forest will deteriorate if the owner cannot afford to maintain it properly. On the other hand, the soil scientist, whose first concern is the preservation of soil quality, is usually against the removal of litter, and points out that in every sound business a part of the profits are returned to compensate for depreciation etc.

This is what actually happens in a forest from which the litter is not removed. The greater part of all the organic matter produced is retained in the standing

timber, while almost all the mineral matter taken from the soil is returned to it in the annual leaf fall. Prof. Nemac of Prague quotes some striking figures illustrating the part played by litter in maintaining a biological equilibrium between the growing forest and the soil. He gives the following average amounts (in Kg.) of nitrogen and minerals in the annual leaf fall on one hectare from beech, spruce and pine forests :—

	Beech.	*Spruce.*	*Pine.*
N.	33	50	40
P_2O_5	10·5	6·4	3·7
K_2O	9·9	4·9	4·8
CaO	81·9	60·9	18·9

*" Nahrstoffverarmung der Waldboden durch Streunutzung." Forestarchiv 1929, 24 (497—503).

If these quantities are annually removed over a period of years, the consequent impoverishment of the soil should ultimately be detectable by chemical analysis. Nemac analysed a number of comparable soils from litter cleared and untouched mature forests, and found the following average losses of nutrient substances from the cleared plots, expressed as percentages of the amounts in the untouched plots :—

Spruce forests.

Soil depth cm.	Org. matter %.	N %	P_2O_5% Total.	P_2O_5% Citric sol.	K_2O,% Total.	K_2O,% Citric sol.
0—2 ..	61	60	64	77	45	53
5—10 ..	24	31	40	20	10	13
10—25 ..	28	28	1	12	3	0
Pine forests.						
0—2 ..	72	88	67	92	0	73
5—10 ..	57	61	10	27	0	28
10—25 ..	10	2	0	14	0	2

The huge losses of N and P_2O_5 from the surface layers, and the smaller losses of K_2O are very remarkable. They are reflected in the following analysis of the ash of pine needles from cleared and uncleared stands :—

	% of ash cleared.	% of ash uncleared.
P_2O_5	6·9	10·4
SiO_2	7·8	9·8
K_2O	44·7	21·2
Na_2O	3·3	13·0
CaO	9·3	10·2
MgO	3·7	6·4
SO_3	5·5	7·5

The litter cleared forest was obviously suffering from phosphate deficiency, while at the same time, in spite of a loss of citric soluble potash, the percentage of potash in the needle ash has more than doubled. For some unexplained reason, this nutrient seems to respond differently from the others to the removal of litter. The nitrogen content of the needles fell on an average by about 12%.

The change in the composition of the ash should ultimately upset the balance of physiological processes and react harmfully on the growth and quality of the trees.

A further common result of litter removal is the physical deterioration of the soil. As a consequence of the reduction in the amount of basic material present, the soil tends to lose its crumb structure, becomes compacted, and sometimes forms hard pan. Nemac quotes an investigation by Tschermak, who found that the average pore volume of seven litter cleared beech soils in Austria was 61% against 77% in comparable uncleared soils. From a scientific standpoint it would seem that the only cases in which litter removal can be justified are where the condition of the humus layer is so bad that it seriously interferes with aeration and water percolation, *e.g.*, on certain strongly podsolised soils in moist regions. Even then, the removal of the humus layer will at best only slow down the progressive deterioration of the soil ; positive amelioration cannot be effected except by a fundamental change in the properties of the existing humus layer,—a process in which success can only be assured by a very careful study of the soil types, ecology and climate of each region.

[Imperial Bureau of Soil Science, Rothamsted Station, Monthly Letter No. 23, September 1933.]

STATE FORESTS OF INDIA

While on the subject of timber, a very useful and attractive little book was presented to visitors to the India Section of the British Industries Fair this year, dealing with the many natural resources of the country ; the Department of Overseas Trade, and the Office of the High Commissioner for India especially, are to be congratulated on its attractive preparation.

From this book we quote the following :—

The State forests of British India cover an area of some 250,000 square miles, and their administration is in the hands of the Indian Forest Department. India was the first portion of the Empire to recognize the value of her forests and to take steps to conserve them. The Forest Department was created some 70 years ago, and now numbers some 400 gazetted officers. The number of tree species in India is upwards of 2,500, but owing to the rapidity with which timber in the Indian forests is attacked by insects and fungi, and the difficulties of transport, extraction has hitherto been limited to the comparatively small number of durable woods. The most valuable tree is sandalwood, which is chiefly utilised for the distillation of its essential oil. From the constructional point of view, the best known species is teak, of which large quantities are exported, chiefly to the United Kingdom. Other timbers of importance, most of which are consumed in India are (*a*) for general

construction and sleepers: deodar. sal, pyinkado, hopea, chir, kail and mesua; (*b*) For decorative work: ebony, rosewood, laurel, shisham, padauk, gluta, red sanders, thitka, koko and silvergrey, (*c*) for general utility purposes: haldu, aini, jak, poon, toon, gurjan, gumbar, jarul, mango, hopea, mesua, bijasal, kindal and irul. Some striking examples of the use of Indian timber for decorative purposes are to be seen in India House (London), where silvergrey, laurel, Burma padauk, and koko have been used for panelling, koko and gurjan for flooring, and rosewood for the front doors and for some of the furniture. The quantity of the timber extracted from the forests in 1929—30 was two million tons of 50 cubic feet. The Forest Research Institute, which was constituted at Dehra Dun in 1906, is now the largest in the Empire, and conducts research into all problems connected with the formation of forests and the utilisation of their products. Notable instances of the results obtained are the adoption by the railways of certain Indian timbers for use as sleepers after impregnation, and the demonstration of the commercial possibility of utilising bamboos for the manufacture of paper pulp. The supplies of this product are almost inexhaustible. The net revenue received from the forests is in the neighbourhood of two million sterling. In addition to timber, the forests yield large quantities of minor products, *e.g.*, bamboos, grasses, drugs, tanning materials, gums and resins.

(*Engineer of India, March* 1934).

INDIAN FORESTER,

AUGUST, 1934.

INDIAN SEMUL COTTON PLANTATIONS, LIMITED.

A pamphlet issued by Indian Semul Cotton Plantations has come into our hands which contains several statements which the ordinary reader might think were based on figures supplied by the Forest Department. In order to correct this view, we will consider some of the statements made with reference to the statistics of growth and yield available in the statistical branch of the Forest Research Institute.

The Company's literature states that they plant their semul 6′ × 6′ or 1,397 trees (1,210 is the correct figure) to the acre and that subsequent thinnings may reduce this number to some extent, and that in the opinion of experts the trees will attain a girth of about 6′ in 10 years. They then in their statement of profits take the production at 1,000 trees 6′ girth to the acre at 50 cubic feet per tree or a yield at 10 years of 50,000 cubic feet to the acre, a yield greater than that given by any tree for which commercial yield tables have yet been compiled.

Mr. Perrée, late President of the Forest Research Institute and a Conservator of Forests in Assam, in a note on semul plantations dated 15th February 1920 estimates that a 6′ girth would be obtained in 25 years and that each tree would produce 75 cubic feet or 1½ tons, but that at this rotation there would only be 12 trees to the acre equivalent to 900 cubic feet. To come now to the figures of actual sample plots, these are given in the following table :—

Sample plot.	Age.	No. of trees.	Average girth.	Standing Volume stem timber.
Henzada	12	48	4′ 6″	2229 cubic feet.
Gorakhpur	16	126	2′ 9″	1001 „ (natural).

The volume tables and growth curves for *Bombax malabaricum* published by the Forest Research Institute (Indian Forest Records, Vol. XV, Part IV) give at 35 years a girth of 5′ 10″, and the latest calculations on the file are reproduced below :—

STATISTICS FOR GOOD CONDITIONS.

(Gorakhpur, Coorg, Burma, Assam.)

Age Years.	No. of stems per acre.	Diameter inches.	Standing volume c. ft.	Thinnings. No.	Thinnings. Volume. Periodic c. ft.	Thinnings. Volume. Accumulated c. ft.	Total production c. ft.	Mean annual increment c. ft.
1 ..	200	..	..	..	..	..	..	..
10 ..	75	15	900	125	625	625	1,525	152
20 ..	40	22	1,600	35	1,050	1,675	3,275	163
30 ..	30	27	2,250	10	550	2,275	4,475	150
40 ..	25	31	2,500	5	375	2,600	5,100	127
50 ..	22	35	2,920	3	300	2,900	5,820	116
60 ..	20	38	3,400	2	260	3,160	6,560	110
70 ..	20	41	4,200	..	..	3,160	7,260	104

We regret to have to contradict the statement that an average girth of 6 feet will be obtained in 10 years. Further considering that only 44 sal trees of 6′ girth can be grown to the acre, how can a widely spreading and intensely light demanding tree like semul possibly stand at maturity at the ridiculous distance of 7′ × 7′ apart which spacing would only give 899 trees to the acre.

We have no reason to doubt that no more than 35—40 trees of 6′ girth can be grown to the acre and that 25 years will be required for this purpose. These figures put a very different complexion on the financial calculations of the Company.

THE ARTIFICIAL REGENERATION OF TROPICAL EVERGREEN FORESTS IN SOUTH BENGAL.

BY H. G. CHAMPION, I.F.S., SILVICULTURIST, F. R. I., DEHRA DUN.

For a long time now, we have felt uneasy about the progress of *natural regeneration in our tropical evergreen forests in which* exploitation fellings of one sort or another have been going on. From the exploitation side, it has been evident that each cycle of fellings was likely to give a smaller outturn of commercial logs than the last, even with cautious felling on a long cycle. Young trees of the valuable species are generally deficient in numbers, and sapling regeneration often rare or absent. The position was surveyed and summarised at the 1929 Silvicultural Conference, the chief resolution on the point stressing the need of research into the problem before extensive fellings were recommenced. Since then there have been useful articles in the *Indian Forester* with a considerable bearing on the point from Assam, Madras and the Andamans, though these have mostly dealt more with the moist deciduous types of forest.

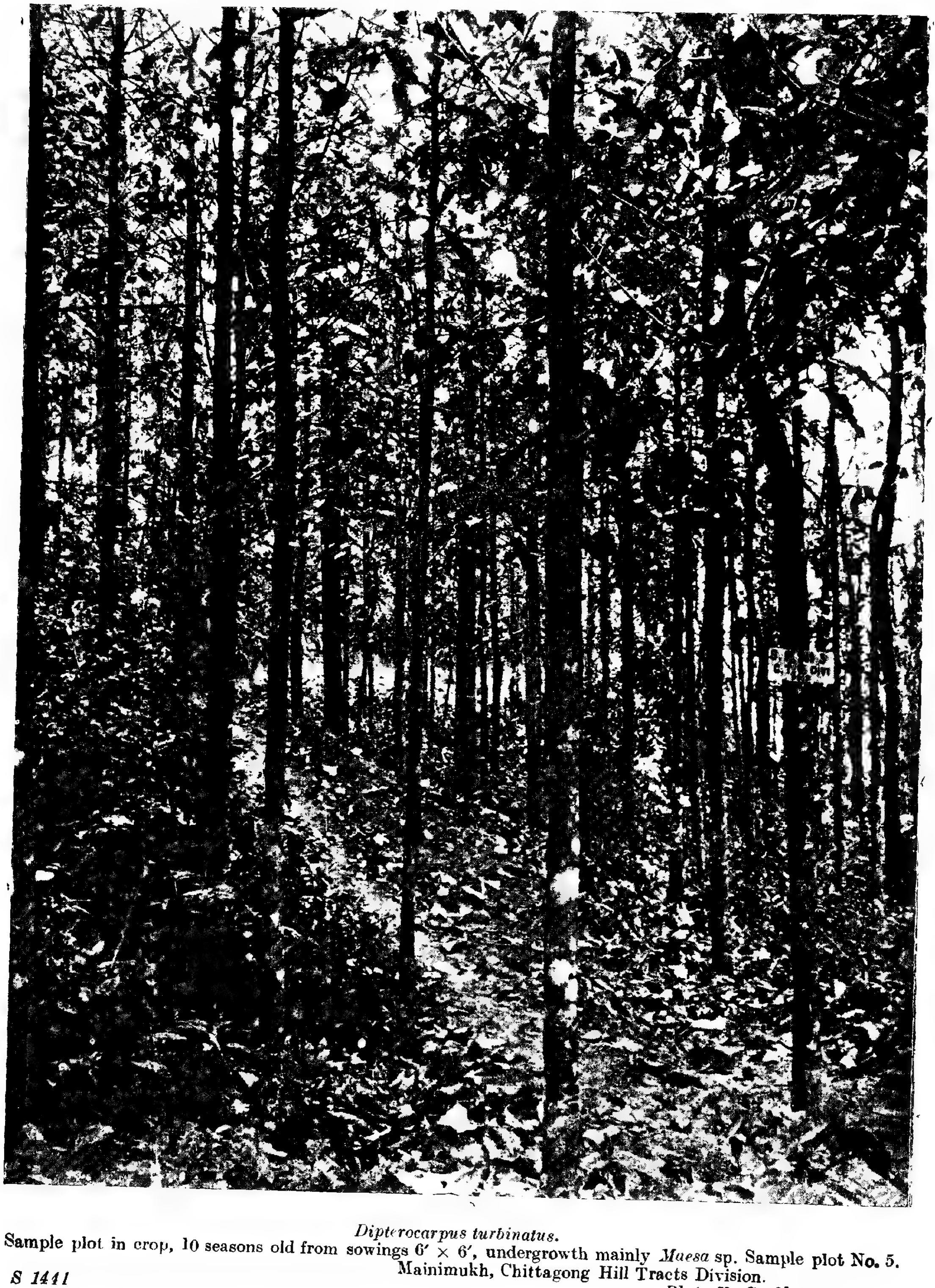
Some of the evergreen forests do contain a fair amount of sapling regeneration, especially of certain species which seem specially adapted to establishing themselves and maintaining a straight leading shoot under heavy shade, such as several species of *Dipterocarpus*, and of others like *Cullenia* and *Dichopsis*, which sometimes come up in quite dense groups. South Bengal in the Chittagong Hill Tracts has such areas, but apart from the fact that when one makes a close examination, one usually finds that such regeneration is decidedly local in its distribution, the work of freeing it, and removing without damage *all the unsaleable material overshading and competing with it*, is so slow and expensive that many officers with plantation experience have felt that clear felling and planting, if practicable, would be the sounder economic proposition. So for a good many years now, those responsible for the Chittagong forests have been trying their hand at raising the saleable timber species under plantation conditions. I was able recently to see the results of their labours and the forests around, and at their request, propose to give a short account of what

I saw, glad to be in a position to draw attention to some really excellent work. There has been the closest co-operation between the divisional and research staffs and much credit is also due to the subordinate staff who have been continuously on the spot during the trying monsoon period.

The Silvicultural Conference brought out the need of a classification of forest types even within the category of "tropical evergreen." Such a classification is unfortunately still not available, so it is necessary to give some description of the original forest type of the tract. The following note was taken down on the spot in the Kasalong reserve which is undoubtedly the climatic climax for the lower more level tracts.

The forest in its virgin condition is a dense evergreen type with an irregular top storey (1) of outstandingly large and tall trees among which the following are prominent:—*Buchanania lancaefolia* (civit), *Dipterocarpus pilosus*, (rarely *D. turbinatus*). The main canopy (2) is irregular in height and somewhat in density also; the chief trees are *Dichopsis polyantha* (*tali*), *Artocarpus chaplasha*, *Sterculia alata*, *Bombax insigne*, *Eugenia* spp., *Amoora* spp., *Calophyllum polyanthum* (*kamdev*). *Taraktogenos kurzii*, *Mesua ferrea*. *Quercus* spp., *Castanopsis* spp. *Elaeocarpus* spp., *Myristica* spp. and many others. There is a varying amount of bamboo (3) though its absence is perhaps typical and *Oxytenanthera* (?) *nigrociliata* (*kala serri*) is the chief species; small palms also occur notably *Licuala peltata*. Finally there is an undergrowth (4), which is mostly composed of seedlings of the bigger trees and merges with the lower middle canopy with no definite break, though plenty of species which never grow larger are of course present.

Climbers vary greatly in amount from very heavy (parts of the Preservation Plot) to insignificant amounts, always greater wherever the canopy is for any reason lighter. *Ancistrocladus extensus* which in its earlier stages appears as an erect shrub, is characteristic. Epiphytes are not conspicuous though *Asplenium nidus* occurs and creeping aroids are common.



Dipterocarpus turbinatus.

Sample plot in crop, 10 seasons old from sowings 6′ × 6′, undergrowth mainly *Maesa* sp. Sample plot No. 5. Mainimukh, Chittagong Hill Tracts Division.

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Photo H. G. Champion.
Nov. 1933.

The forest is cut up by rather deep swampy *dhepas* carrying a lot of cane, and *Lophopetalum* an important lofty tree is confined to their vicinity.

The forests near Hazarikhel, another experimental centre on hilly ground, are generally similar though with some difference in composition and with more deciduous, or semi-deciduous trees such as *Tetrameles, Bombax insigne, Chickrassia, etc.* Those around Bhimoria-ghona are again somewhat different in composition and general development, being rather less luxuriant, with *Dipterocarpus* spp. (other than *D. pilosus*) often predominating; this may be associated with the light soil and rapid drainage, or with human activities including the occasional leaf fires which run through the forest, their very possibility indicating drier conditions. Finally, a good deal of the work has been done near Kaptai in the Hill Tracts along the Korna-fuli River; and here the indications appear to support the belief that a type generally similar to those described has been cleared for shifting cultivation at some perhaps fairly remote time, and we now have to deal with second growth in which bamboos are a conspicuous feature, the giant trees of the primeval evergreen forest are gone, and deciduous species are freely sprinkled, even to predominance, among relatively inferior evergreen.

Dipterocarpus turbinatus.—The earliest attempts at raising any of the evergreen species artificially of which I saw or heard anything, were made in 1922 at Mainimukh and Hazarikhel. In the former locality, a couple of acres were sown up with *Dipterocarpus turbinatus*, but as they were not too successful, fillings were done with *Gmelina* to which the few surviving *garjan* form an understorey; no more *garjan* sowings were done here till 1930. In the latter place, a few scattered trees survive from a small patch sowing of that year. From 1924, we have a definitely successful little plantation in the same locality, part of which is good enough for a sample plot which was laid out in March 1931, when the crop height was 26′ and the dominants well over 30′.—See Plate 47.

Evidently borrowing from *Shorea robusta* practice, line sowings were then tried with such pronounced success that this method has

been followed ever since. The considerable area under these line sowings of 1928 has closed up and looks most promising at an age of six seasons : it is not quite ready for thinning, but may need this operation in one or two more years. In the next year's plantation, 1929, *Tephrosia* was sown as a cover crop between *garjan* lines with good results, and this then became the regular practice and a number of experiments have been made to determine the best time for sowing the cover crop.

At Bhimoriaghona, various small scale experiments in 1927 showed that line sowings with *Tephrosia* shade were quite a feasible proposition, and every year since then a useful sized area has been succesfully sown up. Here too the 1928 plantations are just closing up despite the heavy *Eupatorium* with which it has to compete—(Plate 48). Unlike Hazarikhel and Mainimukh, where all plantations are made with *taungya*, Bhimoriaghona is departmental work without agricultural crops, a difference which entails both advantages and drawbacks.

The aggregate area sown up each year at the three centres mentioned is as follows making quite a useful total, and rather than give details of the individual plantations, a brief account will be given of the procedure now favoured.

Approximate area of plantation sown up annually at Hazarikhel with *Dipterocarpus turbinatus*.

	Mainimukh.	Bhimoriaghona.	Hazarikhel.
	Acres.	Acres.	Acres.
1922	2	0	1½
1923	0	0	..
1924	0	0	2
1925	0	0	2
1926	0	0	5
1927	0	0	25
1928	0	9	23
1929	0	12	12
1930	20	13	15
1931	26	30	..
1932	0	13	5
1933	0	30	13
Total ..	48	107	103

Dipterocarpus turbinatus.
Taungya line sowings 6 seasons old, the *Tephrosia* lines having died out.
Bhimoriaghona, Cox's Bazar Division.
Photo H. G. Champion.
Nov. 1933.

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Dipterocarpus turbinatus.
One season old line sowings. sown 25-5-33. with *Tephrosia* sown 15-4-33.
Bhimoriaghona, Cox's Bazar Division.

S 1413 *Photo H. G. Champion.*
Nov. 1933.

The seed of *Dipterocarpus turbinatus* ripens just at the break of the monsoon (3rd or 4th week of May) in contrast with that of the other local species *D. pilosus*, *D. costatus* and *D. alatus* which all ripen before conditions are favourable for germination and seedling development. It likewise contrasts markedly with them in being relatively free from the insect attacks which render them so difficult for artificial regeneration.

The preparation of the clearfelled coupe and the burning are as usual. Where no *taungya* crops are raised, *Tephrosia* seed is sown first in mid-April being broadcast right up to the *garjan* lines on poor sites, and in a central strip one foot wide on good sites—(Plate 49). The *garjan* seed is sown in triple lines just as is *Shorea robusta*, as soon as the seed is available. With *taungya*, the optimum date of sowing of the *Tephrosia* has yet to be determined. In the richer moister localities, there would appear to be no serious objection to waiting till the second year, but in the drier areas, particularly on exposed ridges often with shallow soil, shade is needed during the first hot weather. If the *Tephrosia* is sown when the paddy is reaped, in September, it germinates well and full lines are obtained, but they are only about 8″ high by the hot weather, the *garjan* lines being already 12″—16″ high. If it is sown with the last weeding in August, a good deal of it may fail (which can be remedied by re-sowing in September), but the rest reaches about the same height as the *garjan* and provides useful shade to the latter and to the soil.

The seedling lines are weeded departmentally or by the cultivators in the first and second seasons—*taungya* crops are paddy, cotton and vegetables, one crop only—and very little subsequent work is needed except where *Eupatorium* or other weeds get out of hand or the *Tephrosia* is too luxuriant. The treatment of the *Tephrosia* itself has not yet been standardised, and at present differs from that in North Bengal in that instead of coppicing it back at the beginning of its third season, it is more usual to top and trim it only as found necessary from time to time. The ostensible reason is the danger from *Eupatorium*, but with the high standard of work of the last year or two, it was noted that there is very little *Eupatorium*

present at the time the cutting back is due, and in future it may possibly be found best to follow the North Bengal procedure here also.

The average height to be expected from the *garjan* lines under fairly favourable conditions during the first few years is about :—1st season, 9–12″; 2nd season, 3—4′; 3rd season 6—8′; 4th season, 9—12′; 6th season, 15′; 10th season 30′.

In addition to these pure plantations, some lines at Hazarikhel were sown in 1930 with a mixture of *Artocarpus chaplasha* which has proved to be definitely the quicker grower but may perhaps prove a useful addition.

Various experiments have been made in under sowing *Dipterocarpus turbinatus* in lines or patches under-thinned *Gmelina* plantations of various ages. The results are quite pleasing in some instances as the 1929 sowing at Hazarikhel under 1922 *Gmelina* and the 1928 sowing at Mainimukh under 1926 year *Gmelina*. and as pure *Gmelina* now seems unlikely to carry on satisfactorily to maturity, it is probable that it will be heavily thinned out in future, perhaps remaining as single trees in the *garjan* crop. Mixtures in the first year have also been tried in 1931 and 1932 with the *Gmelina* spaced $8' \times 4'$ or $12' \times 3'$ and intermediate lines of *garjan* line sowing. It has been found necessary to cut back or prune the *Gmelina* at an early stage, and appearances suggested that an 8′ x 8′ initial spacing might be preferable, to be treated entirely for the benefit of the *garjan*, though a few *Gmelina* might remain to maturity. In some of these mixtures, the *garjan* lines were alternated with lines of *Dichopsis*.

Dipterocarpus pilosus, D. costatus and D. alatus.—It is fortunate that *Dipterocarpus turbinatus* is one of the most appreciated species of *garjan* since the results obtained with it in plantations are very much better than those with the other species. Very little work has been done with *D. alatus*, but a great many trials have been made of *D. pilosus* and *D. costatus*, not entirely without result, perhaps, but still with so disappointingly little in contrast with *D. turbinatus* that they have virtually been given up. The reason is unquestionably the difficulty—almost impossibility—of getting sound seeds, and the

fact that its ripening season is nearly always too early. Like all *Dipterocarp* seed, it is very difficult to store for more than a matter of days, and if sown, either dries up in the soil or germinates, and the seedling shrivels before the monsoon is sufficiently established. As natural regeneration occurs sometimes fairly profusely, it is evident that the difficulties should be capable of solution though they will always remain an important practical objection to the use of species other than *D. turbinatus*.

The best *D. pilosus* work seen was perhaps an underplanting by patch sowing in 1928, 6′ x 6′ under 1922 *Gmelina* which had been previously thinned. This is now under observation as an experimental plot (E. P. 1, Hazarikhel) the *garjan* being 5 –10′ high.

In the nursery (Hazarikhel), all three species have been tested and found to transplant quite well if moved with a little soil. Rather unexpectedly, they are found to take quite well from stumps except perhaps *D. costatus* not yet adequately tried out.

Dichopsis polyantha.—The species to which most attention has been given after the *garjans* is *Dichopsis polyantha*, locally known as *tali*, a tree of moderate dimensions but frequent occurrence in the richer forests where also the sapling and young pole stages are more frequently met with than is usual for the other important associated species. The timber is of quite good quality and ordinarily finds a ready market. Line sowings in the open at Mainimukh made in 1930 appear to be suffering from exposure and the lines are irregularly stocked mainly owing to dry season casualties. Although adequate tests with *Tephrosia* or other cover crop cannot be said to have been made, the indications are that *Dichopsis* requires shade at least in its first few years. Patch sowings were made in 1929 under a seven year old teak crop of good growth, the teak being very lightly thinned the following cold weather and heavily thinned three years later. These have come up quite well, the stocking is good and the average height at least two feet, many plants being much taller. It must be remembered that the canopy was low and dense till the last season, for very much quicker height growth is possible.

During the last four years, trials have been made with mixtures with *Gmelina*, the latter to be treated as the secondary species. Various spacings have been tried from the *Dichopsis* in quincunx with 6′ x 6′ *Gmelina*, to lines between *Gmelina* 12′ x 3′, and at present, line sowings between *Gmelina* 8′ x 8′ or 6′ x 6′ seem indicated as the probable optimum. It is evident that the *Gmelina* must be carefully watched, and trimmed or cut right back as required. The alternate line mixture of *garjan* and *tali* with a *Gmelina* nurse crop has already been mentioned—the relative heights are interesting, being 1½′, 1½′ and 15′ respectively. If the *Gmelina* is gradually reduced to an occasional tree here and there and the *tali* can be retained as a second storey to the *garjan*, the end result should be a most valuable mixture.

Nursery trials at Hazarikhel indicate that the species can be transplanted successfully, but does not stump well. Actually direct sowings are obviously the best method. Growth is reasonably quick, the beds which have been allowed to grow up without special attention and very crowded having reached 11′ in 4 seasons.

Artocarpus chaplasha.—The third important species is *Artocarpus chaplasha*, unfortunately restricted by force of circumstances to areas free from the attentions of wild elephant—unfortunately, since apart from its excessive edibility, it is admirably suited for being raised in plantations. Plenty of seed is available, germination is good and growth is rapid. An excellent small pole crop from patch sowings of 1924 is providing a sample plot adjoining one of the same origin of *Dipterocarpus turbinatus* which it definitely exceeds in height. This plot is now 10 years old and needs thinning.—(Plate 50).

Since 1930, this *Artocarpus* has been freely used at Hazarikhel in line sowings with *Tephrosia* exactly as described for *garjan* from which it differs in being rather more sensitive to exposure, not doing too well on hot slopes or ridge crests, and scorching extensively if ever suddenly uncovered in cleanings or trimming of the cover crop. On suitable ground, it grows more quickly than the *garjan* with which it has occasionally been mixed. It should be noted

Artocarpus chaplasha.
Line sowings on hilly ground, 4 seasons old (1930).
Hazarikhel, Chittagong Division.
Photo H. G. Champion.
Nov. 1933.

S 1431

that although locally, it is somewhat browsed by deer. *Cedrela*, *Chickrassia* and *Gmelina* appear to be preferred. It should be at least a foot high at the end of the first season and 4′ in the second and grows 3–5′ annually in the next few years, the 10 year old plot being about 35′ high.

Hopea odorata.—*Hopea odorata* has naturally been tried, but owing to its slow early growth is more difficult in these *Eupatorium* infested areas. The recorded experiments go back to 1924 but little remains of the earlier trials. Line sowings of 1927 have given saplings 2″ in diameter, but continuous cleanings have been necessary, as also in the 1930 area. It is evident that methods particularly adapted to the species will have to be developed, and it would be worth trying it with a *Gmelina* nurse crop on the same lines as under investigation for *Dichopsis*. Incidentally the excellent results of freeing local patches of natural regneration from overhead cover is worth mention, particularly as it is so closely parallel with experience with the South Indian *Hopea parviflora*. The average height of 1930 regeneration weeded in 1931 and the canopy mostly removed in 1932, was 7″, 14″, 23″ and 42″ after successive growing seasons as compared with 7″, 13″, 17″ and 21″ in the control with full canopy. In the nursery and experimental garden, it presents no difficulties, reaching a height of about 10′ in three seasons as compared with 5′ or 6′ in the plantations. It takes well from stumps (100 per cent. success) and attains the original seedling height in the first season.

Other species which are under study in the Hazarikhel nursery and experimental garden are *Mesua ferrea*, *Calophyllum polyanthum*, *Eugenia grandis* (which has also made quite a good start as line sowings with *Tephrosia*), *Lophopetalum fimbriatum* and *Taraktogenos kurzii*, apart from the more or less deciduous *Swietenia macrophylla*, *Chickrassia*, *Vitex* spp., etc., and the results so far obtained are sufficiently promising for larger scale trials out in the plantations.

It is realised that the typical tropical evergreen forest is a mixed forest in which certain species may predominate in fairly large groups but not over continuous extensive areas. This does not of necessity mean that artificially raised crops of the commercially more valuable

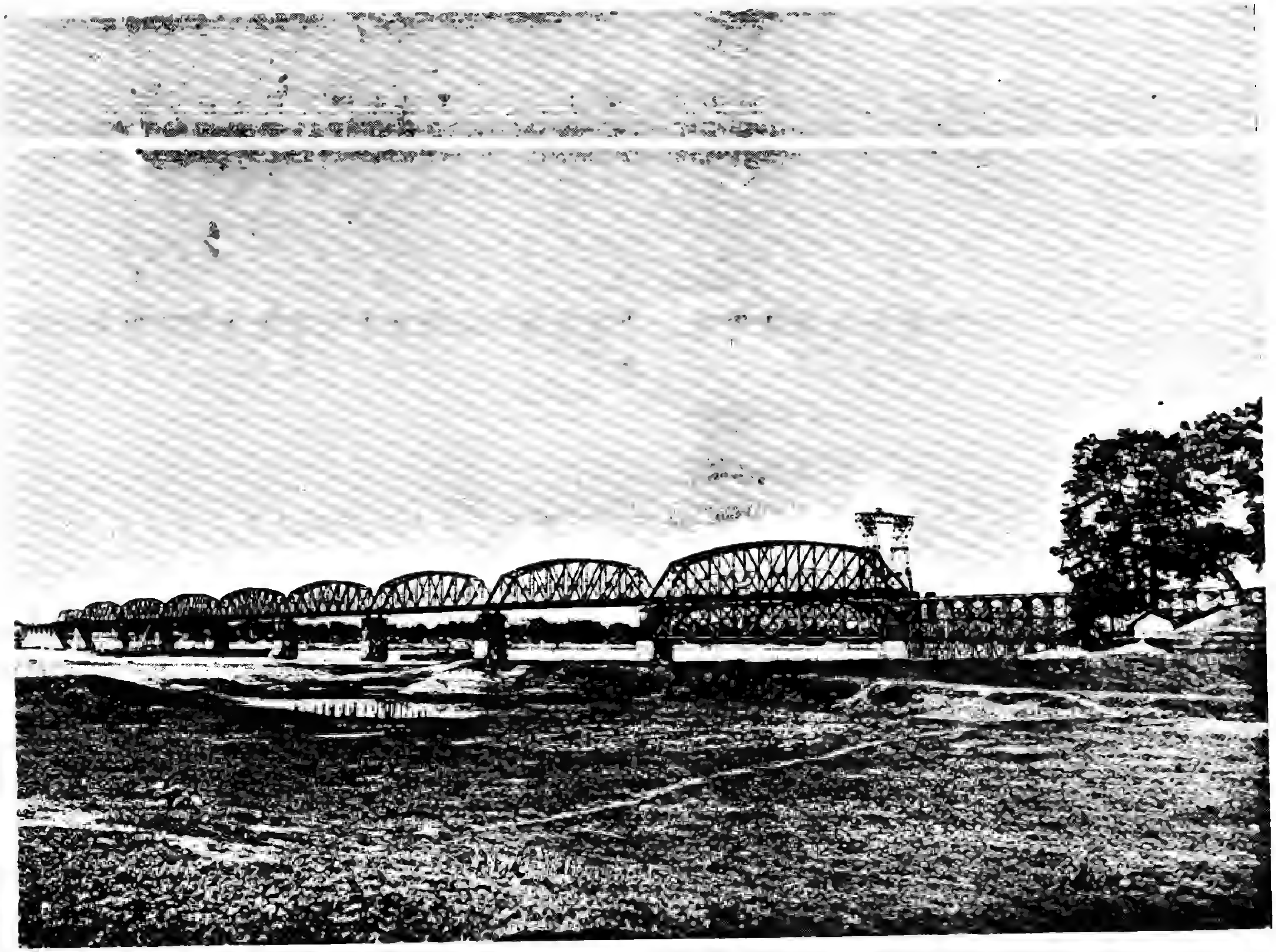
species must of necessity be equally mixed but it does suggest the advisability of developing our knowledge of several of the important species simultaneously and determining to what extent they can be combined. The experiments made wisely concentrate on the simpler problems, the single species plantation, and the two species mixture in the first place, and it can be claimed for them that the results to date are very encouraging indeed. The economic aspects of clearfelling a virgin evergreen forest when much of the timber is unsaleable and must be burnt, will not be discussed here. Actually with the present depressed timber market, the work has been reduced to the minimum compatible with keeping a skeleton organisation of experienced staff and labour, but it is intended to expand once more as soon as the standard timbers such as *garjan* and *tali* again find a reasonable sale.

In conclusion, it may be stressed that this important problem of the management and regeneration of our evergreen forests has to be dealt with from the practical point of view. European experience is not really in a position to help us, having so little in common that few generalisations from Europe can be viewed as more than suggestions worth bearing in mind. Other countries with tropical evergreen forests are in much the same position if as advanced as ourselves, even if locally, as with the *Dipterocarpus* forest of Malay, natural regeneration has proved possible. It is therefore incumbent on us to work out our own methods and to consider the economics of the matter on our own data. The contribution to our knowledge made by South Bengal in the last few years is a most valuable one, and the way is paved for considerable further development which should be a great help both locally and in several other provinces of India.

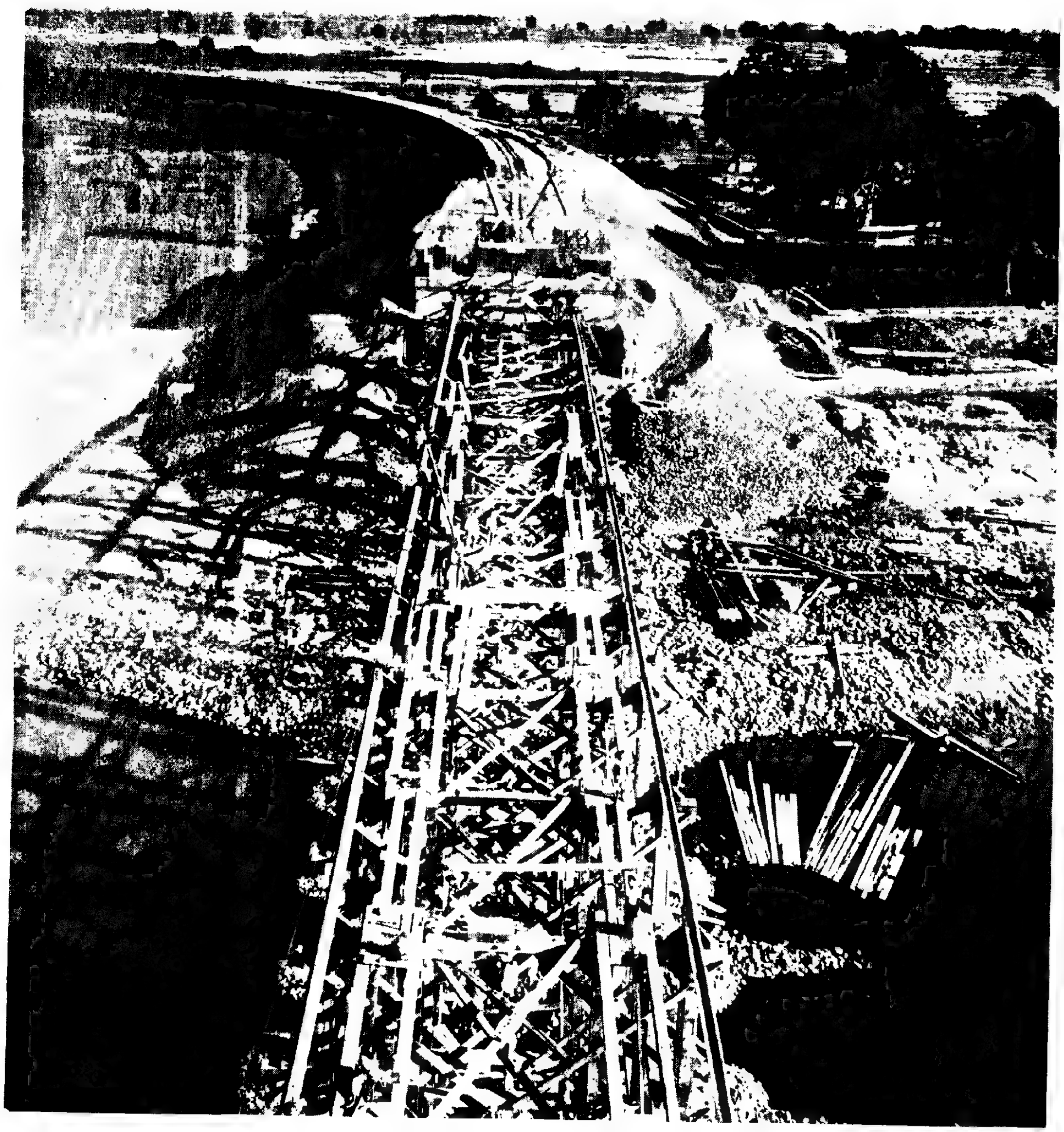
WOODEN RAILWAY BRIDGE BUILT OF GURJAN ACROSS THE IRRAWADDY.

By C. W. Scott, I.F.S., Forest Economist, Burma.

The accompanying photographs (Plates 51 and 52) of the bridge under erection show how the timber was used. The nearer view was taken from the top of the crane visible in the general view.



Wooden Railway Bridge.



Wooden Railway Bridge.

2. The timber was in the form of 40′ and 60′ squares, 12″ by 12″. In 1927-28 when the Burma supplies were arranged and delivered the quotation for imported Oregon pine (Douglas fir) was Rs. 150 per ton at Rangoon, 40′ and up, 12″ × 12″. Rangoon is 400 miles by rail from the bridge site.

3. The Burma squares of *kanyin* timber (known as *gurjan* in the Andamans and India and *apitong* in the Philippines) were supplied mainly by or through the Burma Forest Department at Rs. 100 per ton at railside in the Katha district, about 200 miles from the bridge site. These squares were carefully selected and passed. About 25 per cent. of the logs proposed for squaring had to be rejected, mostly for end defects. Some of these were cut into shorter lengths and passed and sold as 28′ to 32′ squares, 12″ × 12″. As far as possible the rejection was done at stump by Forest Officers, to save expense by the timber contractors.

4. Twenty-four squares of 60′ length and 350 squares of 40′ length (169 tons in all) were supplied at Rs. 100 per ton. A further 400 odd tons of 28′ to 32′ squares (12″ × 12″) were supplied at Rs. 80 per ton.

5. Subsequently a considerable quantity of *in* or *eng* timber (closely related and similar to *kanyin*) of smaller size and easier specification was bought in the Mandalay market at Rs. 30 per ton and used along with the *kanyin* squares. The bottom trestles seen in the photographs and 60 per cent. of the other trestles were of the higher grade *kanyin* and the remainder were of the lower grade *in* or *eng*.

6. The *kanyin* squares were cut in 1928, put into use about two years after cutting, used successfully for four years (1930-33) until the completion of the bridge and were then classed as unserviceable. The bridge contractors, however, are sending about 50 tons of the later bought cheap *in* or *eng* timber by rail and sea to Broach, near Bombay, for further service.

7. Although 60′ squares were asked for and supplied, actually no lengths over 40′ were used in the bridge work. The difficulty and costs of production and transport increase rapidly with lengths over 40′ although *kanyin* is an exceptionally tall clean growing tree.

8. Strength and weight data for Burma *kanyin* and *in* and safe working stresses have been published by the Forest Research Institute, Dehra Dun, under Indian Forest Records, Vol. XVII Part 7, and Vol. XVIII, Part 10 (1933). Compared with teak they are some 15 to 25 per cent. heavier and 5 to 25 per cent. stronger except in shear in which *kanyin* is 10 per cent. below teak. In steadiness (low shrinkage) and durability, they are of course much inferior to teak as the respective prices indicate. Both *kanyin* and *in* are reasonably durable but require as much protection as possible from the sun, white ants and wet ground, especially whilst still green.

9. Compared with Oregon pine (Douglas fir), *kanyin* and *in* are about twice as hard, 5 to 35 per cent. stronger and show about 10 per cent. more shrinkage.

10. The main features of the specification observed in the *kanyin* squares for the Ava Bridge were :—

(1) Admissible curve 4″ in 40′ and 6″ in 60′.

(2) No cup shake beyond $1\frac{1}{2}$″ radius from the pith.

(3) Live knots only up to 3″ diameter and one per 3′ length.

(4) No dead knots or included branches.

11. The squares were hand-sawn at stump and dragged or carted within one week to railside where they were stored on skids, 6 inch off the ground and protected from the sun by rough thatch roofing Delivery of the main order for the 360 long squares was completed within eight months well ahead of actual requirements and could have been accelerated. A certain amount of longitudinal cracking occurred but not so much as to cause serious trouble.

12. The Burmese, botanical and trade names of the two timbers are as follows :—

Burmese name.	Botanical name.	Trade name.	REMARKS.
kanyin ..	*Dipterocarpus turbinatus.*	*gurjan* ..	Closely related to Philippine *apitong.*
in or *eng.* ..	*Dipterocarpus tuberculatus.*	*eng.* ..	Believed identical with Siamese *mai-yang.*

13. Owing to the fall in timber prices and the cost of labour in the Katha district of Burma, similar squares 40′ × 12″ × 12″ of *kanyin* or *in* are now obtainable there at about Rs. 50 per ton at rail-side. Allowing Rs. 25 per ton for railing to Rangoon and Rs. 5 for handling there, these squares would cost about Rs. 80 per ton of 50 cubic feet, f. o. b. steamer at Rangoon. The Conservator of Forests, Utilization Circle, Rangoon, is prepared to arrange supplies and passing to approved specifications.

NEW OR LITTLE-KNOWN PLANTS FROM KUMAON.

By Mukat Behari Raizada, M.Sc.,

Forest Research Institute, Dehra Dun.

Most of the plants referred to in the following pages formed part of the collections made by Mr. A. E. Osmaston, Conservator of Forests, United Provinces, during his various tours in the Kumaon Civil Division. These collections he always generously sent to the Herbarium of the Forest Research Institute, Dehra Dun, either for identification or confirmation of his determinations. They being from a region the flora of which is still not fully known naturally contained material of considerable interest.

Apart from such general works as the flora of British India by Hooker, Indian Trees by Brandis and other local Indian floras which mention Kumaon plants incidentally, the flora of Kumaon is known to the outside world chiefly from Strachey's 'Catalogue of the Plants of Kumaon,' revised and supplemented by J. F. Duthie in 1906, and A. E. Osmaston's 'Forest Flora for Kumaon' published in 1927. The former work which is exceedingly valuable includes not only the plants contained in the original herbarium of Strachey and Winterbottom but also the results of previous and subsequent botanical explorations undertaken by Wallich, Royle, Falconer, Jacquemont, Edgeworth, Thomson, Davidson, Duthie, etc.

The plants incorporated in the present communication, however, are not mentioned in any of the above quoted books or other available

literature dealing with the Kumaon flora, nor are they known to the writer as having been definitely reported from Kumaon.

It may better be pointed out here that it was the existence of Strachey's Catalogue and Osmaston's Flora that made it possible to detect these omissions, for had these two works not been in existence, any plants found in Kumaon but not already reported from there would almost certainly have been overlooked instead of being specially collected and sent to the Forest Research Institute Herbarium, Dehra Dun, for identification.

It is my pleasant duty to thank Mr. C. E. Parkinson, Forest Botanist, for the kind help and guidance received in the preparation of this paper. My thanks are also due to Mr. Ganga Singh, Artist in the Botanical Branch, Forest Research Institute, Dehra Dun, for drawing the plates of *Sinomenium acutum*, *Phlogacanthus lambertii* and *Viscum osmastonii* which accompany this paper.

RANUNCULACEÆ.

Clematis smilacifolia Wall in Asiat. Research XIII (1820) 414; Fl. Br. Ind. i, 3.

Previously recorded from Nepal eastwards to Burma and the Malaya Archipelago and from Peninsular India.

'Askot, East Almora Division, Kumaon, 2,500 feet, 4th January 1932. A. E. Osmaston 1474! A climber.'

In the absence of any herbarium record, Mr. Osmaston omitted to include and describe this species in his Forest Flora for Kumaon, although its occurrence in Central and East Almora was reported by Messrs. W. J. Lambert and H. G. Champion. This species is characterised by having simple, shining, rather fleshy cordate-ovate leaves 7-16 cm. long, 7-13 cm. broad, 7-9 nerved at the base and panicles of brownish flowers 2·4-3·5 cm. in diameter with 4-5 coriaceous sepals.

MENISPERMACEÆ.

Sinomenium acutum Rehder and Wilson in Sargent, Pl. Wilson, i (1913) 387.

Menispermum acutum Thunb. Fl. Jap. (1784) 193.

Cocculus diversifolius Miq. in Ann. Mus. Lugd. Bat. iii (1866-67) 10. non. DC.

Cocculus heterophyllus Hemsl. and Wilson in Kew Bull. 1906, 150.

Sinomenium diversifolium Diels in Engler, Pflanzenr. IV-94, 254 (1910).

Known so far only from China and Japan.

'Telipata, Pindar Valley, Garhwal division, Kumaon, 5,000 feet, August 1932, A. E. Osmaston 1523! A climber with woody stems. Flowers July-August, Fruits September.'

Herbarium specimens of this rather peculiar 'vine' were sent to Prof. Dr. L. Diels, Director Botanischer Garten and Museum, Berlin-Dahlem, for confirmation and it is interesting to read his remarks concerning this species. He writes "The Menispermaceæ kindly sent to me (A. E. Osmaston No. 1523) proves to be a very interesting discovery. It is *Sinomenium diversifolium* (Miq.) Diels (Cocculus heterophyllus Hemsl. et Wils.), which is known so far from Japan and China only. I have never seen an Indian specimen of this species. Unfortunately, the flowers of Osmaston No. 1523 are very young. It would be welcome to get them in a more advanced state for confirming the identity with the Chinese form. So far as I can see there are no essential differences."

As this genus is being reported from India for the first time and as an English diagnosis of this species is not available, it is thought advisable to describe the plant in some detail.

A scandent, twining, shrub. Branchlets finely striate, glabrous. Leaves deciduous, alternate, long petioled, ovate, acuminate, cordate at the base, entire, palmately 5-7 nerved, glabrous when mature, 6-12 cm. long, 7-9 cm. wide. Flowers dioecious, small, in slender long pendulous, axillary, and terminal panicles. The male inflorescence 15-25 cm. long, the female 6-9 cm. long. Male flowers: Sepals 6 greenish-yellow, concave, membranous, pilose outside, at length open and subreflexed; the 3 outer oblong 2·5 mm. long, ·8-1 mm. wide, the

3 inner subovate, 1·8-2·5 mm. long, 1·5 mm. wide. Stamens 9-12. Female flowers: Sepals and petals as in male, staminodes 9, carpels 3 semi-ovate, gibbose, glabrous, styles recurved, stigma lobulate. Drupe excentric. bluish-black, 5-6 mm. long about 4 mm. wide, endocarp strongly compressed with echinate tubercles on both sides. Seeds half-moon shaped, with copious albumen, cotyledons accumbent rather shorter than the radicle.

The generic name Sinomenium has been derived from the Greek *sina*, China and *mene* moon, meaning Chinese moon, referring to the home of the plant and to the characteristic crescent or moon-shaped seeds. It is closely related to Menispermum and Cocculus; from the first, it differs in the parts of the flower being arranged in whorls and in the 9-12 stamens and from the second, chiefly in the structure of the flattened curved seeds.

RUTACEÆ.

Citrus hystrix DC. Cat. Hort. Monsp. (1813) 97; Fl. Br. Ind. i, 515.

This species which is probably a native of Lower Burma and Malaya was described originally by Decandolle from barren cultivated plants of Mauritian origin.

'Chami, Gori Valley, East Almora, U.P., 2,800 feet. 5th January 1932, A. E. Osmaston 1478!, 1486! A small tree, apparently growing wild in swampy ground. Fruit (sent separately) 3½″ diameter, 2¼″ high, yellow.'

'Kali-ka-Bagar, on the banks of Gori Ganga river, East Almora division, Kumaon, 15th May 1933, Bis Ram 2181! A small tree 30-40′ high.'

Since this is the least known member of the familiar group of valuable plants represented by the lime and lemon, a short description of this species, which is based on the numbers quoted above is given below.

A small tree 9-10·5 m. high, glabrous in all its parts, armed with longer or shorter, sharp or blunt, straight, axillary solitary spines.

Leaf blade oval or ovate, dark green and shining above, 5-7 cm. long, 3-5 cm. broad, entire or toothed, the teeth short, blunt and rounded, glabrous, notched-in at the rounded tip and borne at the end of the stalk to which the base is joined by an elbowed hinge ; petiole 7-9 cm. long, leaf-like expanded and almost as long as or longer than the blade itself, obversely cordate or obovate-oblong, at base contracted in a simple short petiole. Flowers bisexual 4 or 5-merous, small, white, on very short pedicels forming small clusters in the axils of the leaves or rarely almost solitary. calyx minute ; petals about ·8 cm. long ; stamens numerous ; ovary terminating in a short thick style. Fruit a citron-like berry 9 cm. in diameter about 5 cm. high with a thick yellow rind.

This species is probably truly wild and indigenous within the area.

OLACACEÆ.

Natsiatum herpeticum Ham. ex R. Br. in Benn. Pl. Jav. Rar. (1838-52) 245 : Fl. Br. Ind. i, 595.

Known so far from Eastern Bengal and the Himalayas from Nepal eastwards to Chittagong and Pegu.

'Dogari, Haldwani division, U.P., 800 feet, 11th January 1927, A. E. Osmaston 1317 ! A slender climber, stem somewhat woody at base.'

'Senapani, Haldwani, January 1928, H. G. Champion. Dehra Dun Herb. No. 45,243 ! '

A slender climbing shrub : leaves alternate, petiolate, cordate-ovate, 7-9 nerved. Racemes supra-axillary, long, pendulous. Flowers dioecious greenish-yellow, minute, with a foetid smell. Fruit a small, slightly fleshy drupe black when ripe.

LEGUMINOSÆ.

Flemingia involucrata Benth. Pl. Jungh. (1852), 246 : Fl. Br. Ind. ii, 229.

Hitherto reported from Eastern Himalayas, Bengal, Assam, Burma, Central Provinces, Western Peninsula extending to Java.

'Jaulasal, Haldwani division, Kumaon, 800 feet, 29th November 1925, A. E. Osmaston 1274 ! A stout erect herb, 2-5 feet high .'

A very distinct but uncommon species with 3-foliolate leaves and capitate inflorescence ; petioles only ·5-1·7 cm. long, leaflets 3·5-9 cm. long, gland-dotted and pubescent beneath, not 3-nerved secondary nerves 10-12. Heads very villous, surrounded by persistent, dry brown, striate, oblong-acuminate bracts 1·5-2 cm. long.

RUBIACEÆ .

Mussaenda frondosa Linn. Sp. Pl. i (1753) 177 ; Fl. Br. Ind. iii, 89.

'Known from Tropical Himalaya in Nepal eastwards to Assam, Upper Burma, China and Malaya Islands. Also from S. India and Ceylon.

'Thal, East Almora division, Kumaon, 2,700 feet, 27th September 1932. A. E. Osmaston 1504 ! A shrub 4-8′ high. Corolla-lobes orange above, whitish beneath.'

'Rongti, Ram Ganga river, East Almora division, Kumaon, 2nd June 1933, Bis Ram 2298 ! A shrub 6-8′ high, abundant in forest on the banks of the Ram Ganga river.'

This species, which is so commonly grown in gardens as an ornamental shrub, has been up till now known in a truly wild state only in the Eastern Himalaya. There is now, however, every reason to believe that it is also indigenous in Kumaon. It is very conspicuous when in flower on account of one of the calyx-lobes of each flower developing into a white membranous leaf.

ACANTHACEÆ.

Echinacanthus attenuatus Nees in Wall. Pl. Asiat. Rar. iii (1832) 90.

Described from material collected by Wallich in Nepal. Also found in Sikkim and Assam but not so far reported from N. W. India.

'Gori Valley, East Almora. U.P., 3,500 feet, 5th January 1932, A. E. Osmaston 1472 ! A perennial herb in chir forest.'

This species which hitherto was known only from Central and Eastern Himalayas was recently collected by Mr. Osmaston in East Almora, which is merely a westerly extension of its previously known distribution.

It is a pretty perennial herb 30-70 cm. high, with or without large radical leaves 15-22 cm. long, the cauline ones gradually getting smaller upwards and ultimately passing into the glandular-pubescent linear bracts of the inflorescence. Flowers violet 2·5 cm. long in axillary panicled lateral spreading spiciform cymes. Bracteoles wanting. Sepals 1 cm. long, erect. Corolla cylindric equalling the ventricose portion. Filaments and anthers hairy, cells tailed. Capsule nearly 2 cm. long, narrowly oblong, glabrous, 4-valved.

Phlogacanthus lambertii M. B. Raizada sp. nov. (Acanthaceæ-Justiceæ): ab affini P. pubinervio T. And. foliis majoribus, floribus cymulis paucis numerosis (2-4 flores in P. lambertii, 6-10 flores in P. pubenervio). Calycis segmentis longioribus, calycis et pedicillis velutino-pubescentibus haud glabris differt.

An erect branched shrub 2-3 m. high. Leaves opposite 12-20 cm. long, 5-8 cm. broad, elliptic, entire or rather obscurely crenate, long acuminate, base narrowed to form a short inconspicuous wing to the petiole, clothed on both surafces with dense short velvety pubescence when young, only slightly hairy or almost glabrescent, when mature secondary nerves 7-9 pairs, arcuate. Petiole 2-3 cm. long. Flowers pedicelled, bracteate, 1·5 cm. long, orange or buff with dark purple veins, solitary or sometime 2-4 together in short axillary cymes. Pedicels ·5 cm. long. Calyx 5-partite, cleft nearly to the base, the 5 lobes narrowly oblong, acuminate ·7-·9 cm. long. Pedicels as well as the calyx clothed both inside and out with short close velvety pubescence. Corolla rather densely puberulous and glandular outside, tubular, curved upwards, tube narrowly funnel shaped, limb 2-lipped, oblique. Fertile stamens 2, glabrous, curved and protruding beyond the corolla. Anthers 2-celled, oblong, muticous, glabrous. Ovary glabrous, stylefiliform, as long as the stamens. Stigma simple, pointed. Fruit an elongated capsule 2-2·9 cm. long containing 8 pubescent seeds.

'Baram, Gori Valley, East Almora at about 2,500 feet, 15th February 1920, W. J. Lambert, Dehra Dun Herb. No. 22235 !'

'Pipalkot, Haldwani division, Kumaon at 1,500 feet, March 1922, H. G. Champion, Dehra Dun Herb. No. 26274 !'

'Danda, Haldwani division, U.P., 2,800 feet, 22nd January 1927, A. E. Osmaston 1327 ! A shrub.'

'Chami, Gori Valley, East Almora division, U. P., 2,800 feet, 5th January 1932, A. E. Osmaston 1477 ! A shrub.'

After examining all the available Herbarium material of the genus Phlogacanthus at Dehra Dun and Calcutta and having seen T. Anderson's type of *P. pubinervius* I feel certain that the N. W. Himalayan species of Phlogacanthus described above is specifically distinct. It is, however, very closely related to the east Himalayan species of Phlogacanthus, *P. pubinervius* T. Ander., but differs from it in possessing fewer-flowered cymes (cymes being 6-10 flowered in *P. pubinervius*) and larger leaves. The calyx teeth are longer and are velvety-pubescent on the outside as are also the pedicels, whilst these parts are glabrous or nearly so in typical *P. pubinervius*.

LORANTHACEÆ.

Loranthus odoratus Wall. in Roxb. Fl. Ind. Ed. Carey and Wall. ii (1824) 215; Fl. Br. Ind. v. 204.

Hitherto reported only from E. Nepal, Sikkim, Khasia, Cachar and Upper Burma.

'Pungar Valley (a branch of the Sarju) East Almora, U. P., 4,000 feet, 29th January 1932, A. E. Osmaston 1485 ! A parasitic shrub.'

Strachey and Winterbottom's Kumaon list does not include this species and even Mr. Osmaston writes regarding it in his Forest Flora for Kumaon:- "I am very uncertain whether this species really occurs within our area or not, but there are two sheets at Dehra Dun which seem to agree well with the description given in the F. B. I. though their fragmentary nature makes certain identification difficult. These sheets are Duthie's No. 3361 collected in the Ram Ganga Valley, and Osmaston's No. 905 collected at 4,600 feet elevation close to Baijnath."

After examining Osmaston's No. 1485 which is in flower and excellently preserved in the Dehra Dun Herbarium there remains little doubt that this species is truly wild and indigenous within our area.

A perfectly glabrous parasitic shrub. Leaves fleshy, subopposite, elliptic or lanceolate 8-10 cm. long, 2-3 cm. broad, entire, narrowed into a petiole, often falcate, penninerved; nerves slender. Bracts and bracteoles absent. Flowers sessile, small about 5 mm. long, sweet-scented, yellow opposite or fascicled on axillary, solitary or fascicled spikes 3-5 cm. long. Calyx limb short and produced beyond the ovary. Perianth lobes 6 free, spathulate: ovary with the base sunk in the rachis. Style very stout, stigma capitate. Berry ellipsoid, glabrous.

Viscum osmastonii M. B. Raizada sp. nov. (Loranthaceæ-Visceæ); a V. angulato Heyne, cui maxime affinis, habitu robustior, ramulis nodisque teretibus (in sectiones circulares) nec angulatis distinguendum.

A completely leafless much branched parasitic shrub, forming tufts, branching in all directions. Stems jointed, conspicuously ribbed, drying greenish-yellow, 3-14 cm. long and upto 7 mm. in diameter. Joints terete (*i.e.*, circular in transverse section) not flattened or angled even when young, somewhat thickened at both ends 7 mm. 3 cm. long. The whole plant including the perianth very papillose. Flowers monoecious small sessile in triads densely fascicled at the nodes of the branches the ♂ flower usually lateral the ♀ central at first half-enclosed by 2 persistent, small connate bracteoles. Hypanthium (perianth tube) solid in ♂, adnate to the ovary in the ♀. Perianth-segments usually 4 erect, triangular, deciduous greenish-yellow. Stamens as many as the perianth-lobes; anthers sessile, adnate to the perianth segments and dehescing introsely by numerous pores. Ovary inferior, 1-celled, ovule solitary ascending; stigma nearly sessile. Fruit a succulent berry 3 mm. in diameter, globose, greenish-white. Seeds green, somewhat flattened, surrounded by opaque white viscous mucilage.

'Nalia Reserve, East Almora division, U. P., 6,000 feet, 8th January 1933, A. E. Osmaston 1536! Parasitic on *Loranthus vestitus* which was parasitic on *Quercus dilatata*.'

This is Viscum sp. 4 of Osmaston's Forest Flora for Kumaon. According to him it "probably occurs along the whole outer ranges of hills between 2,000 and 5,000 feet but it seems to be rare. It is found parasitic on *Loranthus cordifolius* Wall., and *Loranthus pulverulentus* Wall. Flowers: November-December. There are three sheets of this species at Dehra Dun namely my No. 1291 and Dehra Dun Herb. Nos. 26008 and 23028 collected by Inayat and P. W. Mackinon all from the outer Himalaya."

None of the 3 sheets quoted above is now to be found in the Dehra Dun Herbarium. They were probably sent to Kew for identification or comparison and seem to have been retained there. I have, however, seen (in the Herbarium of the Royal Botanic Garden, Calcutta) a duplicate of Mackinon's No. 23028 collected at about 2,500 feet near Dehra Dun on 7th July 1899 and this agrees fairly well with the type.

The species described above is very near the Deccan Peninsular species *Viscum angulatum* Heyne, but differs from it principally in being more stout in habit and in having all the joints as well as the branches terete and not angular as in *V. angulatum*.

Explanation of the Plates.

PLATE 53. *Sinomenium acutum* Rehder et Wils. 1. Flowering twig showing male inflorescence x ½. 2. Flowering twig showing female inflorescence x½. 3. Seed x1½. 4. Drupe x1½.

PLATE 54. *Phlogacanthus lambertii* M. B. Raizada. 1. Flowering branch x½. *m* 2. Capsule showing the persistent calyx x1½. 3. Corolla tube open with the stamens x2. 4. Ovary with the calyx tube x2.

PLATE 55. *Viscum osmastonii* M. B. Raizada. 1. Plant in flower x1. 2. Portion of the stem showing arrangement of flowers x2. 3. A triad showing a female flower with lateral males x5. 4. Longitudinal section of the ovary showing the solitary ascending ovule x5. 5. Male flower x10.

THE ROLE OF INSECTS IN THE DYING-OFF OF SAL. (SHOREA ROBUSTA.)

By C. F. C. Beeson, Forest Entomologist, F. R. I., Dehra Dun.

Why do sal trees die ? Various hypotheses have been produced from time to time in reply to this question, but the fashionable explanation frequently changes, as a perusal of the *Indian Forester* and Forest Administration Reports discloses. Among the more likely of the causes are drought, unfavourable aeration of the subsoil, instability of forest type, primary attack by borers, defoliation, parasitic fungi, fires, etc. With regard to the role of insects in the dying-off of sal, evidence has steadily accumulated and although the subject is still under investigation by the Forest Entomologist, some conclusions as to the importance of this factor can be drawn.

Insects associated with dying saplings, poles and trees of *Shorea robusta* fall into the three groups : (*a*) borers of bark and wood, (*b*) defoliators, (*c*) sapsuckers.

(*a*) *Borers.*—Biological studies enable us to classify the borers of sal into two groups, *i.e.*, *primary borers* capable of attacking and killing healthy trees, and *secondary borers* incapable of killing healthy trees, but able under certain conditions to accelerate the death of moribund trees.

The primary group is limited to one species, *Hoplocerambyx spinicornis* (Cerambycidae), which normally breeds in freshly felled trees, windfalls, trees washed out in floods, etc., just as the secondary borers do, but which can breed in and kill healthy trees of any age and size by mass attack when its population multiplies to epidemic abundance. There is an extensive literature on epidemics of this species in the Central Provinces and the United Provinces in which is detailed the evidence for rating this borer as a primary species. The important symptoms of primary attack may be summarised here as : (*a*) dying-off from the crown downwards by sudden withering of the foliage in the autumn or spring, (*b*) profuse exudation of resin at points where the first stage larvae bore in the bark, (*c*) healthy condition of the roots. Remedial measures vary with the locality and

the extent or stage of the epidemic, and include removal of attacked trees before the following monsoon by exploitation or bonfires, collection of beetles in July-August, utilisation of trap-trees, annual inspection, etc.

The group of secondary borers comprises a large number of species *Aeolesthes holosericea*, *Cacia cretifera*, *Ceresium* spp., *Chlorophorus annulifer*, *Coptops aedificator*. *Dialeges pauper*. *Diorthus cinereus*, *Epipedocera affinis*, *Nyphasia apicalis*, *Xylotrechus smei*, and *Xylotrechus buqueti* (Cerambycidae); *Acmaeodera stictipennis*, *Chrysobothris beesoni* (Buprestidae); *Schistoceros anobioides*, *Sinoxylon anale* and *Sinoxylon crassum*, *Sinoxylon* spp., *Xylodectes ornatus* (Bostrychidae); *Crossotarsus bonrouloiri*, *Crossotarsus saundersi* and *Crossotarsus* spp., *Diapus furtivus*, *Platypus solidus*, *Platypus curtus* and *Platypus* spp., (Platypodidae); *Sphaerotry siwalikensis*, *Xyleborus kraatzi*, *Xyleborus shoreae*, *Xyleborus submarginatus* and numerous *Xyleborus* spp. (Scolytidae); *Gerontha captiosella* (Tineidae).

The abovementioned are borers of the bark and wood of crown branches and bole: in addition species of *Xyleborus*, and some weevil and prionine larvae bore into roots, often at considerable depths below ground-level.

Symptoms.—The general symptoms of secondary borer attack are: (*a*) dying-off is preceded by drying-up of the crown or stagheadedness, (*b*) there is no sudden withering of foliage, (*c*) the bark remains closely attached to the bole or separates loosely in patches with discolouration of the sapwood, (*d*) resin is not exuded at points of oviposition, (*e*) the roots are dead in parts or diseased, the wood being invaded by hyphae.

The secondary borer fauna varies very considerably in its composition; it provides useful indications of the physiological conditions prevailing in the tree at the time of death. For example, the bark beetle, *Sphaerotrypes siwalikensis*, requires fresh moist bark for its brood-tunnels and is a good indicator of the condition of the bark at the time of its attack. If the bark is quite healthy the bore-hole is at once filled with resin and the beetle is driven out or entombed.

If the bark dries rapidly the beetle is able to oviposit but the brood fails to develop. Cases of dying-off of sal saplings in Ramnagar division in 1926, in Dehra Dun in 1929, in South Kheri in 1930, were observed with these symptoms.

The characteristic borer fauna of stagheaded and dried out crowns comprises *Acmaeodera stictipennis, Chrysobothris beesoni, Sinoxylon anale* and *Xylotrechus smei*. In the larger branches and boles of such trees other characteristic borers are *Aeolesthes holosericea, Diorthus cinereus,* and *Coptops aedificator*. The occurrence of these species, coupled with the absence of other groups, is a good indication that the trees either died of drought or were attacked after the crown and bole had begun to dry out.

A species indicating dry conditions of peculiar nature is the moth, *Gerontha captiosella,* which in all the observed cases (Raipur and Balaghat, Central Provinces, Dehra Dun, Haldwani and Ramnagar, United Provinces) was associated with a saprophytic bark fungus *Hypoxylon annulatum*, that forms a charcoal-like encrustation beneath the outer dead bark, easily mistakeable for scorching by ground fires.

Dying-off with drought as the sole predisposing factor, however, appears to be rare as there are usually complications in the shape of root diseases. Two cases recently investigated serve as examples. In Horai, Haldwani division, U. P., the symptoms were rapid drying-out of the bark of the crowns and upper boles followed by attack of borers of "dry" group and the absence of borers of sappy wood; the presence of *Polyporus gilvus* in the roots of some dying and dead trees and the absence of *Polyporus shoreae*: and finally the presence of *Hypoxylon annulatum*. It was concluded that the dying-off was primarily due to drought on the evidence of the rainfall records, the fall in the subsoil water-level and the extensive drying-up of *Mallotus philippinensis*. In Thano, Dehra Dun division, the crowns died slowly to the accompaniment of the borings of the usual secondary bark and sapwood insects. The boles died suddenly, a withering of the epicormics occurring in advance of attack by secondary borers

in the spring and hot weather. *Polyporus shoreae* was absent but *P. gilvus* and *H. annulatum* were present. Here apparently drought conditions were less severe and the mortality was confined to trees with diseased roots.

Turning now to the borer fauna characteristic of dying-off under normal weather conditions or in localities of high rainfall, we find the indicator species of borers are chiefly the pinhole and shot-hole borers. *Diapus furtivus, Crossotarsus saundersi* and many species of *Xyleborus*. Other reliable species are *Dialeges pauper,* and *Xylotrechus buqueti.*

Attack by *Hoplocerambyx spinicornis*, as a secondary borer, indicates an unresistant condition in the tree at the beginning of the rains.

In the forests of the wet sal type and in some of the moist sal type the root disease, *Polyporus shoreae*, is frequently accompanied by secondary damage to deep roots by termites, prionine larvae and *Xyleborus* spp. Secondary borer attack is distinguished from primary epidemic attack in the regions of high rainfall by the diversity of the incidence of the constituent species. If the analysis of a series of sample trees shows that no species of borer is outstandingly abundant, or, if abundant, is absent from a percentage of the dead trees a diagnosis of secondary attack is justified.

Remedial measures are required in epidemics of secondary borers in order to prevent depreciation of the timber of the moribund trees. They are very much of the same nature as those used for primary borers. Their successful application saves the timber and prevents loss of revenue but does not necessarily stop the dying-off. Cases investigated in recent years in Dehra Dun and Haldwani divisions show that dying-off continues after the borer population has been much reduced by control measures, but the dead trees yield clean timber.

(*b*) *Defoliators.* The list of species of caterpillar defoliators of sal is a very long one and the defoliator fauna is richest in the wet type forests in Assam and Bengal. Although extensive epidemics

of caterpillars, particularly of mixed associations of Lymantriidae, occur periodically in the Bramahputra valley and may last for two or three years, no case of subsequent dying-off on a large scale has been reported.

(c) *Sap-suckers.* The only species of sap-sucking bug that appears in epidemic abundance on sal is *Drosicha stebbingii.* Although Stebbing asserted 30 years ago that twigs and branches dry up and the new flush of leaves and flowers is seriously affected, we have no later reports of wholesale mortality as the result of mass attacks of the bug. The insect is however certainly responsible for stagheadedness and must be regarded as a forerunner of secondary borer attack.

Finally, there is another form of dying-off which is characterised by the formation in the living bark of longitudinal fissures which expose the sapwood. This appears to be a consequence of excessively rapid growth in coppice shoots and in saplings of exposed advance growth. The bark cracks in some localities are invaded by termites and a Coccid, *Pedroniopsis beesoni*, and (*e. g.* Ganjam, Madras) by stem rots, which prevent healing and accelerate deaths.

Conclusions.— Biological investigations on the extensive borer fauna of *Shorea robusta* lead to the conclusion that only one species, *Hoplocerambyx spinicornis,* is capable of killing healthy trees. The secondary borers may accelerate the death of moribund trees, possibly causing death to occur a year or two earlier than would happen in their absence.

No species of defoliators and sap-suckers have been incriminated in the wholesale dying-off of sal, but these pests have not been studied as extensively as have the borers.

The primary causes of dying-off are probably referable to physiological disturbances resulting from meteorolgical conditions.

RADIUS CUTTING AS A METHOD OF SEASONING LOGS.

By Azizul Rahman, U. G. A., Seasoning Section, F.R.I., Dehra Dun.

Among refractory Indian hardwoods, there are certain woods which are greatly liable to surface cracking along the medullary rays

both in the form of log and as converted material. Examples of this are, *Anogeissus acuminata*, *Anogeissus latifolia*. *Adina cordifolia*, and *Buxus sempervirens*. If a log of any of these species is left to season in the air, the cracks soon make their appearance, and can be easily seen on the ends of the log. These cracks penetrate deeper as seasoning progresses, till finally the entire log is rendered useless.

In most species, damage due to cracking can be reduced by converting the logs as soon as possible after felling, and if the logs have to be stored for any length of time, it is recommended that they should be immersed in water. In many cases, however, neither green conversion nor water storage is possible, and logs have to be left to the mercy of the atmospheric conditions, which usually cause an appreciable amount of damage. Under these circumstances, it is suggested that the logs should be given a saw cut along the entire length from the periphery to the centre. This is called a radius cut, and it allows the wood to shrink along the circumference as drying proceeds, and finally the cut opens out into the shape of a V. A log of boxwood (*Buxus sempervirens*) with a radius cut is exhibited in the Timber Museum at the Forest Research Institute, Dehra Dun, and it shows well the extent to which the surface cracking can be reduced by this method.

A preliminary experiment was lately tried to find out the effect of making a radius cut on a log of axlewood (*Anogeissus latifolia*) for the air-seasoning of the log under cover, and the results obtained show that the method has certainly some advantages. One log about 18′ in length was cut into two halves, one portion was given a radius cut, and the other was left in its natural state for comparison. Both halves were left for air-seasoning in one of the seasoning godowns at Dehra Dun, and it was found that the radius cut slowly opened out, and that the end cracking of the half with the cut was much less than that of the other half.

At the end of nine years' seasoning, the timber of both halves was cut up into scantlings, and it was found that the moisture content had dropped down to about 12 per cent. to 14 per cent., which is quite low

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Sections of logs with and without V-Cut.

Photo Har Swarup.
April '34.

for logs. On examining the converted material it was found that practically all the scantlings from the portion without a cut were badly cracked and the material was almost useless. Compared with this, the condition of the scantlings from the log having the radius cut was much better. A photograph of the ends of the two portions is reproduced in Plate 56, from which the difference between the two portions is very evident.

In place of a radius cut, a log can also be cut into halves along a diameter, and it is suggested that if logs of refractory hardwoods are stored in this form, they will not suffer much damage from surface cracking. A more detailed investigation into this method of seasoning is now under consideration. For the present, it is also suggested that a radius cut as described in this note would greatly help in reducing damage due to cracking in case of highly refractory hardwoods.

The one difficulty in this connection is the cutting of a radial cut in logs of great length. If a pendulum circular cross-cut saw is available this is not difficult, but with hand-saws only radius cutting is not easy, except in short logs. In such cases, the best remedy is to cut the logs in half as described above. This can be done without difficulty by means of hand-saws.

THE LIMITATIONS OF FOREST RECONNAISSANCE SURVEYS.

By H. C. King, Divisional Working Plans Officer, Ceylon.

The article under this heading in your issue of February 1934 is of great interest in view of similar work in Ceylon and I enclose some notes on the working plan reconnaissance which was commenced in October 1933 in the Ceylon wet zone.

2. The main object of the enquiry is to ascertain the distribution and exploitable volume of *hora* (*Dipterocarpus zeylanicus*) the commonest and most amenable of the *Dipterocarp*. This species attains a maximum girth of 20′ with a clear bole of over 90′ and reaches 60′ in height before the girth is much over 3′. The timber is therefore

almost cylindrical, the taper being found from the measurement of felled trees to be about 1/5" per foot of bole. *Hora* is gregarious and is confined to soil of definite fertility, usually to the deep rocky soils of the rain forests some distance from the coast. It is associated with 45 other *Dipterocarps* less fully investigated, with 7 *Palaquium* species, and the softwood genera described under "volume." Experiments extending over 6 years suggest that *hora* and *Palaquium* advance growth can be assisted and extended at low cost to effect complete regeneration.

The Agricultural Chemist is studying soil problems in 8 sample areas and his results should throw light on the past history of the much eroded soil of adjoining rubber estates. The flora of each wet zone forest is different and it is at present not clear whether soil is largely responsible for these changes.

3. Four forests were selected for reconnaissance by separate parties, and for statistical purposes nothing was known except that they had been heavily and indiscriminately felled under the old license system. It was also clear that only a relatively small area contained valuable species, shifting cultivation having led to vast stretches of scrub and unproductive secondary growth.

4. The problem was to locate accurately and cheaply the unproductive areas and to locate and assess the commercial value of the much smaller patches of good forest, with special reference to *hora*.

5. The existence of modern 4 chain surveys of most of the reserves and of contoured 1" maps of all 4 working areas is of great assistance. We are very fortunate in having such detailed plans of forest boundaries to work on.

6. The original proposal to carry out a 5 per cent. enumeration in 1 chain strips every 20 chains was finally altered to a system by which a square plot of 1/10 of an acre was enumerated in each acre of valuable forest. A base line 6' wide is laid out accurately on the 4 chain survey and from this a grid of light cut lines is laid out in 32 chains squares over the whole forest. After some training the working plan foresters can traverse these cut lines and plot on a 16 chain diagram

the approximate extent of 3 main types of forest. This process forms stage 1 of the working plan enquiry and it leads to the preparation of 16 chain maps showing in colours the forest areas allotted to :—

(*a*) scrub and blank below 200 cubic yards of firewood per acre ;

(*b*) firewood forest over 200 cubic yards per acre but less than 1,000 c. ft. of timber in trees over 4′ in girth ;

(*c*) forest between 1 000 c. ft. and 2000 c. ft. per acre in trees over 4′ in girth.

No forest containing over 2,000′ per acre has yet been dealt with. The same species occur in all 3 types of forest so that it is not possible to make a distinction by species or forest type.

7. No further work is done in types (*a*) and (*b*) but forest allotted to type (*c*) is enumerated by sample plots on a 10 per cent. basis. Strip " lines " are laid out from the base line at right angles every 4 chains, and at intervals of $2\frac{1}{2}$ chains on these 4 chain strips a peg is sunk as the central point of a sample plot. A very sturdy octagonal "lining compass " is used on tea estates for fixing the planting pegs for tea bushes at such complicated intervals as $2\frac{1}{2}' \times 3\frac{1}{4}'$ and this instrument proves invaluable for laying out sample plots 1 chain square : the compass is set up at the centre, diagonals are cut to the specified length, corner posts are sunk and boundaries opened. At present trees over 12″ in girth are numbered in white paint, measured at 4′ 6″, and the height estimated by Christen—an instrument which is cheap—but not accurate over 50′.

8. The 1″ topographical maps contoured at intervals of 100′ are sufficient for the rough location of main extraction routes, but the working plan reconnaissance has up-to-date been combined with trailer tape surveys to provide precise horizontal measurements of base lines and strip lines. It was believed that the increased cost of trailer tape operations would be repaid by the increased accuracy in the location of central points of sample plots. The modified Abney level is of aluminium and very delicate and liable to incorrect adjustment. Evidence up to date suggests that the ordinary steel survey chain when held horizontal gives results which compare very closely

with trailer tape data and the latter will probably be dispensed with in areas already contoured.

9. The two main difficulties in the work are identification and computation of volume. Very few of the 46 indigenous *Dipterocarps* have been verified by the collection of authentic timbers and botanical specimens. The *Palaquium* genus has been fully explored but its 7 species are not easily recognised by subordinates. This genus and it seems all the *Dipterocarps* showed marked differences between the mature leaf and that of the seedling or sapling. As the work proceeds a working plan herbarium is formed with corresponding timber specimens. A very real difficulty which must occur in any tropical colony is that vernacular names are usually generic and when an authentic specimen is obtained the best vernacular name, or a new one has to be introduced: working plan subordinates have then to be instructed in the leaf, bark and adopted name of the species. Villagers with intimate knowledge of woodcraft are becoming very rare.

Volume.—Meticulous computation of volume of trees of uncertain species is not justified and for practical purposes all species have been grouped for volume computation into 4 classes :—

1. *Hora* *D. zeylanicus.*	2. *Construction timbers.*	3. *Softwoods.*	4. *Firewood.*
Hora.	All other *Dipterocarps.*	*Canarium*	*Chaetocarpus.*
		Cullenia	*Elaeocarpus.*
	All *Palaquium* species.	*Campnosperum*	*Garcinia.*
	Eugenia	*Litsea*	*Aporosa.*
	Calophyllum	*Myristica*	*Macaranga, etc.*
	Carallia	*Semecarpus, etc.*	
	Mesua		
	Isonandra		
	Vitex altissima		
	Lasianthera, etc.		

In the absence of any volume tables it was decided to utilise Hoppus measure, with a rough formula for computing the mid-girth

from the girth at 4′ 6″. The taper in the bole of *hora* is found to be 1/5″ per foot up to a girth of 6′ and $\frac{1}{3}$″ per foot for trees over 6′ in girth and a table was prepared showing for trees of stated girth at 4′ 6″ and stated height of bole, the basal area at a point half-way up the bole. This basal area multiplied by the height gives a volume which is reduced by 10 % to allow for unsound timber. The formula will be checked and elaborated from further fellings so that more exact identification will coincide with a better volume computation for each species. For species other than *hora* 1/6″ taper per foot is allowed for girth up to 6′ and 1/3″ above 6′.

For every 20 consecutive sample plots a summary is prepared showing the number of stems in each girth class and the total volume in trees over 4′ in girth. The topographical details are entered on a 4-chain plan which also gives the exact position of each sample plot : this method, which is perhaps original, has the advantage of showing on the map a sample of the contents of each individual acre—a very useful guide to silvicultural treatment. In strip enumeration it is observed that the results have to be localised by closing the count at 10-chain intervals.

Cost. The cost, for labour only, with the rupee at 1/6 is as follows :

Base line 6′ wide -/08 per chain.

Reconnaissance in Stage 1 -/03 per acre.

10 % enumeration -/50 per acre.

In view of your contributor's remarks on the closely similar results obtained from 10 % and 5 % enumeration, 5 % will almost certainly be adopted in Ceylon when a 5 % test has been applied to the existing 10 % data.

General.—Considering the relatively high timber content of these exiguous reserves and the scope afforded for silvicultural improvement the writer believes that this reconnaissance survey is justified when costs are further reduced by reducing the girth minimum to 2′, by omitting the trailer tape, and limiting the enumeration to 5 %. The royalty system is disappearing and the exploitation of these reserves will be organised under wholesale contractors who require volume

data on which to base their tenders. There is a possible future for *hora* for impregnated sleepers and it may be used as a substitute for the imported *Dipterocarpus turbinatus* and *tuberculatus* (?). The survey should ensure the rational control of future exploitation and give the precise limits of forest areas suitable for improvement and natural regeneration: if the canopy is further interrupted by casual sales as in the past, natural methods of treatment will become impossible: artificial plantations have locally proved an expensive substitute. Under such conditions there seems to be a strong case for extended reconnaissance. Your contributor's main objection to such work is that the information is of no commercial value. In Ceylon the answer seems to be that research into utilization and markets is expected to yield practical results by the time the statistical enquiry is completed.

RESULTS OBTAINED WITH THE KILN DRYING OF LAUREL (TERMINALIA TOMENTOSA) ACCORDING TO A NEW METHOD DEVELOPED AT DEHRA DUN.

By S. N. Kapur, Officer-in-Charge, Seasoning Section, F.R.I.

The usual method of kiln-drying fails to give satisfactory results with a large number of Indian hardwoods on account of their refractory nature. In these timbers, the rate of diffusion of moisture from the interior to the surface is extremely slow, which causes a steep moisture gradient in the wood even during the early stages of drying in spite of maintaining a very high humidity in the kiln. The surface layers tend to dry rapidly to somewhere below the fibre saturation point, and as the drying progresses, a moisture pocket is formed in the interior, which results in case-hardening of the timber, and which requires long and tedious steaming operations both during and after the process of drying. The process then becomes not only lengthy and costly, requiring skilful supervision all the time, but affects the quality of timber to a certain extent due to frequent steamings at high temperatures. In some cases if the surface drying has progressed too

far, it becomes well nigh impossible to drive the moisture out from the centre, except by long periods of conditioning in air and subsequent steaming in the kiln.

Indian laurel (*Terminalia tomentosa*) is one of such timbers, offering considerable difficulty both in air and kiln-seasoning. A large number of experiments have been carried out at Dehra Dun during the last ten years on the kiln drying of laurel and it has not been possible to dry it satisfactorily according to the usual method of kiln-drying, except in the case of planks not over one and a half inches in thickness, and that also with considerable consumption of steam. Kiln-seasoning trials with this timber carried out at the Government Timber Depot at Ahlone, Rangoon, have given similar results, and it is reported that the only satisfactory method of drying this timber is by steaming frequently during the process of kiln-drying, at first in a saturated atmosphere, and later, when the moisture content of timber had dropped below 20 % at lower relative humidities. Working on this method, one inch planks have been dried from green condition to 12 % moisture content in 24 days in an internal fan kiln. Considering the length of period the timber has to remain in the kiln, and the repeated steaming operations, the cost of kiln-drying would be too high for commercial practice, and further it is highly doubtful whether thicker material could be dried on the same principle.

For sometime past, work has been in progress at Dehra Dun on a new process of kiln-drying, which is expected to overcome the difficulty experienced with most of the refractory hardwoods. Briefly stated the process consists in circulating air in a kiln by means of fans fitted inside the kiln, allowing the air to get heated for a short period during which time the temperature rises and the humidity of the air falls, and then allowing the air to cool down by stopping steam to the coils. At the end of the cooling period, the air inside the kiln becomes fairly wet, and is exhausted into the atmosphere, and a fresh charge of cold air is drawn in, which is heated again, and the cycle is thus repeated.

During the heating stage, when hot, dry air circulates around a piece of timber, there is a certain amount of evaporation from the

surface layers, which gives rise to a sort of moisture gradient, as well as to some drying stresses in the wood, but these are confined to the outermost layers of the piece and soon disappear during the cooling stage, when the humidity inside the kiln rises to about the saturation point. In this manner, at the end of each cycle, which may last from 2 to 6 hours, the timber is found to lose a certain amount of moisture, without suffering from any permanent set or case-hardening. As long as the timber is above the fibre saturation point, the relative humidity of air at the end of the cooling period approaches saturation value, but below that point the difference between the wet and dry bulb temperatures tends to become greater and greater, and when the difference amounts to about ten to twelve degrees centigrade, it indicates that the timber is dry enough to be taken out of the kiln.

The increase in the humidity of air, very nearly to the saturation point, during the cooling period helps not only in the equalization of the moisture gradient, and the removal of drying stresses, but also in bringing about a better outward diffusion of moisture in the wood, and thus exerts a beneficial influence on the actual rate of drying of wood. It has been experimentally proved that the diffusivity of moisture in wood increases rapidly as the moisture content increases up to the fibre saturation point. In other words, if the surface layers of a piece of wood are maintained in a wet condition they offer less resistance to the passage of moisture than if the exterior was allowed to dry. In the new process of kiln drying, the high humidity at the end of the cooling stage, raises the moisture content of the surface layers, which are in a better condition for drying when the hot dry air is made to circulate around the wood.

Experimenting with small pieces of wood, it has been found that the moisture in wood moves in the direction of the temperature gradient. If a piece of wood, well protected against surface drying, is heated at one end, it is observed that the moisture tends to move towards the cooler end. With the new process of drying, it has been observed that during the period of heating and for sometime afterwards, there is a rise of temperature in the interior of the piece of wood,

and during the cooling stage, a distinct temperature gradient is established from the interior to the surface. During this latter period, as the heat flows out from the interior, it tends to bring out moisture towards the surface and thus helps in driving the moisture out from the wood.

The process as described above has a number of advantages. In the first place it is very economical in steam consumption. It has been found that in a small sized kiln, having a capacity of 150 to 200 c.ft. of sawn timber, the consumption of steam is about 3 lbs. for each pound of moisture evaporated from wood. As no steam is used at all for maintaining the necessary humidity inside the kiln as in the old process, and no intermediate and final steaming treatments are usually found necessary for the removal of drying stresses, this means a considerable reduction in steam consumption and consequent saving in the working expenses as compared with the old process.

Simplicity of operation is another feature as compared with the usual method of kiln-drying. All that an operator has to do is to open and close steam valves at stated intervals, and he is free during the rest of the time. This work can also be performed easily by means of time switches. According to the old method, an operator had to look after a kiln continuously to see that the proper temperature and humidity conditions were maintained.

Another great advantage is that the kiln need not work all the 24 hours. Most woodworking factories close during the night time, and for the sake of the kilns, the boilers have to keep working continuously, entailing considerable extra cost. With the new process, the kiln can be shut down during the night period without any loss in efficiency.

The cost of drying with the new process is fairly low, on account of the reduction in steam consumption and the simplification of the method of operation. It is reckoned that in a kiln with a capacity of about 1,000 c. ft. per charge, the cost of drying 1″ thick sissoo (*Dalbergia sissoo*) would not exceed annas four per cubic foot. For one inch laurel planks, the cost would be under annas 6 per c.ft.

For carrying out the process it is necessary that the kiln should be of internal fan type, having reversible propeller fans and inside heating coils. If the fans and heating coils are fitted above the drying chamber, it is useful to have an auxiliary heating coil on the kiln floor. On the other hand, if the heating and ventilating equipment is situated below the drying chamber, small dampers should be left in the partition walls of the fans, which can be operated from the outside. This arrangement enables a very feeble circulation of air to be maintained in the stack of timber, due to temperature differences, by allowing a small amount of steam to leak into the heating coils below the drying chamber. It is further necessary that the walls should be of moisture-proof construction. An interior fan kiln with a capacity of about 200 c. ft. per charge can be built and equipped for about Rs. 1,500 to Rs. 2,000. It, therefore, enables small wood-working establishments to put up and work small seasoning kilns for their own requirements.

The method of kiln-drying outlined above has been tried on a number of timbers and fairly satisfactory results have been obtained. The one great difficulty that has been experienced is the influence of the kiln walls on the drying conditions inside the kiln. Kiln walls of the usual brick and mortar construction have considerable capacity for absorbing moisture evaporated by the circulating air from the timber in the process of drying, with the result that at the end of the cooling period the humidity of the air is not as high as one would expect in a kiln of non-porous construction. This disturbing influence of the walls is felt all the more in small sized kilns, where the quantity of wood is very little compared to the wall area. As long as the rate of evaporation of moisture from wood is far in excess of the rate of outward diffusion of moisture through the kiln walls, the results obtained with this process are really remarkable.

The experimental work on the new process of drying is being carried out in miniature kilns on the internal fan principle, of brick construction, having interior dimensions of $4' \times 4' \times 4'$, and capable of holding 6 to 8 c.ft. of timber. A number of trials have been made

with laurel, and it is expected to carry out work during the year with other refractory species, namely kindal (*Terminalia paniculata*), axlewood (*Anogeissus latifolia*), amoora (*Amoora wallichii*), hopea (*Hopea parviflora*) and some others. The timbers are sawn into scantling sizes, such as 2″×4″ or $2\frac{1}{2}$″×$2\frac{1}{2}$″, and if success is obtained with these timbers in thick sizes, the commercial utility of the process is assured.

As already stated, it has been possible to cut down the period of drying considerably for the timbers tried so far. For instance, 1 inch planks of laurel have been dried successfully in 12 days from an initial moisture content of about 68% to 10% moisture content, with no appreciable increase in degrade. This is perhaps the shortest time in which this timber has ever been kiln-dried. Scantlings of the same timber, $2\frac{1}{2}$″ × $2\frac{1}{2}$″ in cross section, have been dried in 21 days from 64% to 9%, and the resultant material showed almost complete freedom from case-hardening stresses and a very uniform distribution of moisture in the wood. Although the results obtained to date are fairly successful, it is not yet possible to state the best conditions of drying for any timber, as considerable more work has yet to be done. In addition to empirical trials of various arbitrary schedules, work is in progress at present to determine the loss of moisture in various stages of heating and cooling, the flow of heat into and from the wood and consequent changes in moisture content of various layers, the development of stresses in the wood, the necessary modifications to the kiln for evolving the most suitable type for the process under consideration, and numerous other factors having a bearing on the problem.

As an indication of the kind of schedule that has so far been found suitable for a refractory timber like laurel, the following conditions are reproduced from a kiln run of $2\frac{1}{2}$″ × $2\frac{1}{2}$″ scantlings of laurel, dried from 64% to 9% moisture content in 21 days.

The timber was dried in a small internal fan kiln, having fan and other heating coils at the top. An extra heating coil was fitted at the floor for bringing about a slow thermal circulation through the stack of timber in the kiln during the early part of the cooling period.

(i) Steaming.

The timber was steamed for 2 hours in 3 periods of 50, 40 and 30 minutes respectively, with intervening air circulation for $1\frac{1}{2}$ hours each time and a final air circulation for 2 hours. At the end of the steaming period, the air was exhausted for 10 minutes.

(ii) Drying.

Days.	Heating with fan working. Max. Temp.	COOLING WITH FAN STOPPED.		Exhaust.
		Heat in the bottom coil.	No heat.	
	OC.	Hours.	Hours.	Minutes.
1—3 ..	55	$\frac{3}{4}$	1	2
4—5 ..	58	$\frac{3}{4}$	1	2
6—7 ..	60	$\frac{3}{4}$	1	2
8—9 ..	60	$1\frac{1}{4}$	$1\frac{1}{2}$	..
10—14 ..	60	$1\frac{1}{4}$	$2\frac{1}{2}$	..
15—17 ..	63	$1\frac{1}{4}$	$2\frac{1}{2}$	..
18—20 ..	65	$\frac{3}{4}$	3	..
21 ..	70	$\frac{1}{2}$	3	..

(iii) Conditioning.

During the cooling period, the fan was allowed to run for about 8 hours, admitting a small quantity of live steam into the kiln through the steaming pipe for about 5 minutes every hour, the temperature not being allowed to exceed 55°C.

(iv) Final Tests.

21 sticks were cut up for moisture tests, which gave an average moisture content of 10·9%, the least being 9·5%, and the highest 13·5%. There was no surface and end-cracking of the timber and the material was particularly free from case-hardening stresses. The moisture distribution in the sticks was fairly uniform. The material was obtained from Bihar and Orissa, and was dark coloured,

A charge of 1″ planks of laurel varying in width from 8″ to 12″ was dried in one of the large internal fan kilns at the Forest Research Institute. The initial moisture content was between 50 % and 68 %, and the drying was completed in 12 days. A number of tests were taken at the end of the drying process which showed a very uniform distribution of moisture, and an almost entire absence of case-hardening stresses. On the basis of this charge, the following conditions are recommended for the drying of 1″ planks of laurel from the green condition :—

(*i*) *Steaming.*

Steam for 2 hours in 3 periods of 50, 40 and 30 minutes with intervening air circulation for 1 to 2 hours, and exhaust at the end for 10 minutes.

(*ii*) *Drying.*

Days.	Heating with fan working. Max. Temp.	Cooling with fan stopped.		Exhaust.
		Heat in the bottom coil.	No heat.	
	CC.	Hours.	Hours.	Minutes.
1—3 ..	55	$\frac{1}{2}$	1	5
4—6 ..	60	$\frac{3}{4}$	$1\frac{1}{2}$	3
7—10 ..	65	1	2	..
11—12 ..	70	1	3	..

(*iii*) *Conditioning.*

During final cooling, keep the fans working and admit a slight amount of live steam into the kiln for 3 to 5 minutes every hour, for 4 to 6 hours.

The conditions given above are by no means final, but should give good results if the walls of the kiln are not too absorbent. It is recommended that the interior of the kiln should be painted with some water-proof paint, and that the doors and windows should be made fairly air-tight.

Summary.

(1) A new process of kiln-drying is described, based on alternate heating and cooling of the circulating air inside the kiln. During the heating period, the timber is exposed to hot, dry air, but during the cooling stage the humidity of the air rises to very nearly the saturation

point, and this helps in eliminating moisture gradient as well as drying stresses in timber.

(2) The new process costs much less to kiln-dry a timber on account of the reduction in steam consumption and simplification of the method of kiln operation.

(3) For carrying out the process, an internal fan kiln with some slight modifications serves the purpose.

(4) Details of a successful kiln run of $2\frac{1}{2}'' \times 2\frac{1}{2}''$ scantlings of laurel are given. Drying conditions for 1″ planks of laurel are also recommended.

A FORMULA FOR DISCOVERING IF THE SELECTION FOREST IS SUFFICIENTLY MATURE FOR CONVERSION TO UNIFORM FOREST.

BY W. D. M. WARREN, I.F.S., D.F.O., KOLHAN DIVISION.

Some time ago I found myself searching for a formula by which, from enumerations made in Selection forest, one could tell reasonably quickly whether that forest was mature enough for conversion to the uniform system or not. The occasion for this search arose because of criticism, which had been levelled at this conversion of our selection forests. It had been pointed out, and there seemed to be a large measure of truth in the statement, that conversion involved a large amount of sacrifice of immature poles and trees and that in consequence it was not worth while. The criticism admitted that the sacrifice of poles was perhaps inevitable and that they quickly grow up again, but when it came to trees,—3′ to 4′ in girth—trees in their prime, the sacrifice seemed too great. In spite of my enthusiasm for the conversion systems especially in places like the Singhbhum forests, where regeneration and coppice shoots are there already, simply asking for the overwood to be clearfelled, in spite of that I was rather disturbed by the thought of the apparent sacrifice involved, until I looked up a few outturn statistics from our P. B. I. areas, and then I found that sometimes as much as 50 per cent. of our 3′—4′ girth trees were unsound. Such a large percentage seemed extraordinary seeing that the higher girth classes dropped in hollowness to 5 or

10 per cent. until 7′ girth was reached when hollowness again increased. The only way I could account for it was that in a normal selection forest the 3′—4′ girth class tree is suppressed by the older girth classes and that this continual suppression in time caused the tree to go unsound. This theory is confirmed by actual observations. In ideal mature selection forest, the 3′—4′ tree is very often found to be suppressed.

At the time I discovered the formula, I happened to visit one such ideal mature selection forest just about to be converted. Very few of those 3′—4′ girth trees looked healthy, little sacrifice would be involved, I thought, in their felling to make a way for a new even aged crop of youngsters. I looked up the enumerations of trees over 3′ in girth made by the Working Plans Officer and found that for every 100 trees enumerated, 49 trees belonged to the 3′—4′ girth class and 51 were 4′ and above. I took 4′ as the dividing line between the two groups because the contractor of big timber begins to get interested in trees once they reach that girth, whereas those below 4′ he treats with contempt. Here then was my formula, 49 trees of 3′—4′ girth to 51 trees of above 4′. And as I have already said, I knew from observation that little sacrifice would be involved in felling those 3′—4′ trees.

In order to confirm matters, I turned to the enumerations made for the Kolhan Working Plan. In this case 48,613 trees were counted, and the ratio of 3′—4′ trees to 4′ and over was 47·2 to 52·8. This showed that the Kolhan forests were even more mature than the ideal compartment I had been looking at. I then turned to the enumerations made for Saranda Division and found that the ratio for the 301,343 trees enumerated there, was 49 to 51, exactly the same as in my ideal compartment. Consequently I think it may rightly be concluded that the ideal ratio lies between 47·2-49, 3′—4′ trees to 51-52·8 trees of above that girth. In fact anything like 50/50 is pretty good. The more we depart from that ratio in favour of more trees of the smaller girth, the less will those trees suffer from suppression, there being more of them to be suppressed and fewer of the

older trees to suppress them, until a stage is reached when the smaller girth trees are hardly being suppressed at all, are growing vigorously, in fact, in their prime. Such a stage appears to be reached when the ratio is 60 trees or more of the smaller girths to 40 trees or less of the larger girths. When such happens, a real sacrifice is involved in converting that compartment—a sacrifice which ought to be avoided if possible in the opinion of the writer. A waiting period should be insisted upon in order to allow the trees to become more mature.

[NOTE.—Mr. Warren's statement regarding the unsoundness of the 3′ sal trees in the selection forest will, I think, be correct for other sal areas under selections. Mr. Turner found much unsoundness in quite young poles in Working Circle I of North Kheri. Owing to the generally poor conditions of sal poles in selection forests, I have always considered the even aged sal forest a much better silvicultural conception than the typical selection forest. Much of our hill selection forests are not really typical selection forests at all. The young crops of coppice origin which have been obtained as the result of conversion to uniform look likely to give far better results than anything we have had in the past under selection. Constant dying back and constant suppression must have injurious results on the tree and it is waste to retain such a crop of trees to provide the future yield. There can be very little sacrifice in converting rotten poles into a new crop. So far as the distribution of the girth classes go in the ideal selection forest my friend Mr. S. H. Howard and myself had a long controversy on this subject in these pages some years ago which decided nothing.

If number of trees be converted to volume units with the usual 2 : 3 : 4 ratio for 4′—5′, 5′ -6′, 6′ girth classes and 6′ be taken as the exploitable girth, with the usual triangular representation of the normal forest, the old wood (over 4 feet) should be in the ratio of 20 : 7 to the 3′—4′ girth class, *i.e.*, roughly 3 : 1 which is the same ratio as one would find with equal numbers of 3′—4′ trees at 1 unit and trees over 4′ at 3 units each. This does not necessarily denote maturity. No real statistical examination of this " sacrifice " on conversion has yet been made, but I consider that conversion can be made without the sacrifice of an undue number of thrifty young trees. All rubbish must come away but as complete uniformity is not necessary, very great latitude can be left to the D. F. O. to retain anything even up to 4′ girth which can be retained with advantage. This is the system actually in practice in Dehra Dun division, and the results of some conversion fellings I have seen are quite satisfactory. C. G. TREVOR.]

REVIEWS.

A GAME BOOK FOR BURMA AND ADJOINING TERRITORIES.

By E. H. Peacock, Deputy Conservator of Forests and Game Warden of Burma (Retired).

(*H. F. & G. Witherby*, 326 *High Holborn*, *London*, *W. C.* *Price* 12*s.* 6*d.* *net.*).

Burma has waited a long time for a practical book dealing authoritatively with the pursuit of the many varieties of game to be found within her frontiers. The publication of Mr. Peacock's Game Book proves that this wait has not been in vain.

Mr. E. H. Peacock was particularly well qualified to fulfill Burma's want in this respect and no one probably could have performed the task more efficiently. In sportmanship, wood-craft and practical knowledge of game and how to outwit it, Mr. Peacock was unsurpassed,

his enthusiasm for wild life protection and anxiety for the perpetuation of Burma's fauna was exceptional.

Mr. C. W. Hobley, C.M.G. the Secretary of the Society for the Preservation of the Fauna of the Empire, has written a foreword to the book, the practical and broadminded nature of which should, as Mr. Peacock says, enlist the sympathy of the reader in an organization which has done incalculable good in the interests of wild life throughout the Empire.

The book, which is divided into five parts, is excellently arranged and admirably illustrated. Mr. Peacock's pictures of *saing* and bison which deserve special praise are believed to be the finest photographs yet taken of these beasts in their natural surroundings. Some very good sketches of tracks are included and there is a useful sketch-map of Burma showing the boundaries of the various forest divisions.

In Part I under the head of General Information will be found authoritative replies to most of the numerous queries likely to be asked by anyone unfamiliar with local conditions desirous of pursuing game in Burma. Whether the reader's ultimate object be a trophy, a photograph or mere observation he will find in these chapters much to assist him in his choice of grounds, weapons or apparatus. Mr. Peacock's statements that photography of big game has hitherto left Burma practically untouched and that his flashlight photographs of tiger were taken with apparatus costing not more than £3 should stimulate interest in this very fascinating form of hunting.

Parts II and III deal respectively with large and small game and there, concerning each particular animal or bird, a great deal of interesting information is given concisely and systematically under a number of different heads, such as description, numbers and distribution, habits, food, senses, sounds, breeding, tracks and legislation. In the case of the game birds simple keys are given to facilitate the identification of species and sub-species. The information contained in these chapters is mainly the result of the author's personal experience, but this for the sake of completion has been supplemented

by references to the most up-to-date and authoritative works on the subject. The result is a comparatively complete and easily readable guide to the larger fauna of Burma.

Part IV deals with Miscellaneous Mammals, Birds and Reptiles, and Part V with Fish. The value of the information given in Part IV is increased by the fact that the classification and nomenclature adopted in the case of all the mammals anticipates that which is likely to be followed during the next revision of the Fauna of British India and Burma—Mammalia.

Mr. Peacock's book covers a wide range and constitutes a mine of information for the sportsman, photographer and naturalist. Compression must have been the author's main difficulty and Mr. Peacock is to be congratulated on the very successful way in which he has completed his task.

No one interested in the wild life or sport of Burma should be without this easily readable but most instructive book, the price of which is very moderate.

H. C. SMITH.

THE CULICINE MOSQUITOES OF INDIA.

CULICIDAE.—Tribes Megarhini and Culicini. by Capt. P. J. Barraud, Entomologist to the Malaria Survey of India; *Fauna of British India*, Diptera. Vol. V. pp. 1-XXVII. 1-463, 8 pls., text-figs.. March 1934. Price 30 shillings.

Closely following on the publication of Christophers' volume on the Anopheline mosquitoes (October 1933),* a companion volume by Capt. P. J. Barraud has now appeared on the Culicine mosquitoes; this concludes the account of the Indian Culicinæ, the sub-family of the Culicidæ, which, according to our present classification includes all the true mosquitoes.

In 1900 only four identified species of Culicidae were recorded from India. The number of species of the sub-family Culicinæ

* Reviewed in the *Indian Forester*, Vol. LX, April 1934, pages 294–295.

(including 43 Anophelini) has now reached a total of nearly 300 species. For the sake of completeness the very few (16) Indian members of the remaining sub-families Dixinæ and Chao-borinæ are described in an appendix by Dr. F. W. Edwards, sub-editor of the *Fauna* series and dipterist at the British Museum; these are mosquitoes that do not suck blood.

The Culicini, in contradistinction to the Anophelini, are, of course, the main mass of mosquitoes, none of which carry malaria. The Culicines are, however, associated with other diseases. Very little work has been done on the transmission of dengue in India, but *Aedes aegypti* and *A. albopictus* are known to be carriers in other parts of the world, and these two very common species probably transmit the disease in India. *Culex fatigans*, one of the commonest domestic mosquitoes in most parts of this country, appears to be the chief carrier of filariasis, but other species may also be concerned. It breeds in domestic collections of water and in the overflow from houses, kitchens, etc., and not in pools or streams if far from human habitations. Yellow fever has not up to the present occurred in India, but the Indian race of *Aedes aegypti* is capable of transmitting this disease. It breeds in artificial collections of water near or within houses, such as pots, chattis, shallow tanks, gutters, etc.

The information on the distribution and habits of the mosquitoes described in this volume is the result of several years' work by the author under the auspices of the Indian Research Fund Association. The larvae of about a hundred species are still unknown but keys for the identification of larvae and pupae are given wherever possible.

There are 106 figures in the text, and eight plates with numerous microphotographs of adult mosquitoes.

C. F. C. B.

EXTRACTS.

NATURAL RESINS.

Extract from H. V. Potter's Speech at the A. G. M. Plastics Group, April 18th, 1934.

There has been a movement among producers and distributors to get better, cleaner and more standardised products on the market. The grading and marketing of American, French and other rosins has been on a well-established basis for many years past, as befits an industry which in volume alone is the biggest unit of trade in either the natural or synthetic field, amounting to 600,000 tons per annum. Considerable work of the same nature has been done and is being done for the dammars of the Dutch East Indies and Malaya and the Congo copals in Belgium and elsewhere.

Though grading and standardisation are of great importance in these days of stringent buying specifications, research into present uses of natural resins to improve processes and devise new ones and also to find new outlets and uses for these resins has been extended to many products and in many countries.

Rosin has been the subject of much research and backed by large and financially strong organisations, much successful work has been accomplished. The copals are being investigated both in regard to their chemical constitution and application at the Louvain University.

Shellac is being exhaustively investigated at the Brooklyn polytechnic, New York, at the Indian Lac Research Institute, and by the London Shellac Research Bureau.

So far no definite results are available for publication though Dr. W. H. Gardner of N. Y. and Dr. Aldis have published a series of papers of considerable interest to lac users. A new edition of Tschirch's " Natural Resins " appeared early in 1934 and gives ample evidence of the extent of the research work being undertaken in Germany on the subject.

It appears likely that natural resins will find many uses in combination with synthetic resins and that work along this line of application will develop rapidly. Instances are already available in the case of the oil-soluble resins, a variety of which are now on the market, consisting of various combinations of the two groups of products. Modifications of the natural resins such as their esters, their dewaxed state and so forth have also yielded valuable products. In brief, research, standardisation and reasonable stability in price, hold out excellent prospects for a renewed lease of life for the natural products, and what at one time looked like developing into a pitched battle between " Natural " and " Synthetic " is rapidly becoming a real union of forces for evolving better products to the lasting advantage of both and we are likely to hear more of these combined products in the future.

Gramophone records are still principally made from lac in spite of the repeated assertions that it is to be replaced by acetate. When lac rises and remains at over 1/- per lb. the cellulose derivatives are likely to be more attractive.

Shellac and other natural materials such as copals, bitumens, etc., are still used in the production of cheap electrical and other mouldings where cheapness is the only factor. Heat resisting and shock-absorbing mouldings can be produced by incorporation of special fillers but such mouldings are always made by the stamping process and cured afterwards.

GERMAN PLANT FOR PRODUCING ALCOHOL AND GLUCOSE FROM WOOD.

BY C. H. S. TUPHOLME, 4, N. HYDE PARK MANSIONS, LONDON, N. W. 1, ENGLAND.

The production of alcohol from wood is not a new process, and a plant was established as long ago as 1910 in the United States, employing waste shavings from a sawmill as raw material and dilute sulphuric acid as the saccharification medium. The production of alcohol became important in Germany during the war and various plants were laid down. The latest of these is that at Mannheim-Rheinau, and this has recently been described before the Institution of Chemical Engineers by Friedrich Bergius.

This plant was completed in May 1933 and has been in continuous operation for some months. Already, says Dr. Bergius, it has been shown that the same yield of carbohydrates from wood can be obtained as in the first commercial plant installed at Geneva, now closed down. The large Rheinau plant has a diffusion battery capable of a yearly production of from 6,000 to 8,000 tons of pure carbohydrates. The size of the diffusers is five times that of each diffuser of the Geneva plant, 20 cubic meters, or about 700 cubic feet, but whereas the Geneva diffusers were built of acid-resisting Prodorite, the Rheinau diffusers are of iron, lined with small acid-resisting tiles joined together by a special cement.

The wood, which normally contains from 20 to 40 per cent. of moisture, is first cut in special shredders and mills, and is then dried in a revolving drier until it contains about 1 per cent. of moisture. The heat for drying the wood is furnished by the waste heat of the boilers. Before being introduced into the diffusers, the dry wood is moistened with a solution coming from the last diffuser containing sugar and hydrochloric acid, and is then transported to the diffuser No. 1 and dropped in through the top opening. After allowing a short time for the reaction to take place in this newly filled diffuser, No. 1, fresh highly concentrated hydrochloric acid is pumped into the last diffuser, No. 8. The liquid contained in this diffuser is then transported to diffuser No. 7, the solution from No. 7 to No. 6 and so on. The solution at the top of diffuser No. 1, containing normally about 35 per cent. of sugar, is drawn off to the distillation plant, and a new filling operation may then be started. Vessel No. 8 is washed out systematically, giving a solution with from 37 to 38 per cent. of hydrochloric acid, which is then led to the regeneration plant.

The recuperation of the 40 per cent. hydrochloric acid is performed by the absorption of hydrochloric acid gas by the acid from the washing process and takes place in a plant specially constructed for the purpose. Special means of cooling

are necessary to remove the heat generated in recuperating the acid and to keep the acid plant within reasonable dimensions. There is no perceptible smell of acid during the normal running of the plant when producing 40 per cent. hydrochloric acid. In the evaporation station the hydrochloric acid is distilled under a vacuum of about 30 mm. of mercury at temperatures of from 40 to 45° C. The iron parts of the evaporator which come in contact with the hydrochloric acid are covered with a special rubber. Condensation of the acid vapours is effected in stoneware coils which, however, are shortly to be replaced by another type of condenser built of protected iron.

At the same time, the acetic acid originating from the wood and contained in the battery solution is distilled and condensed, together with the hydrochloric acid. When the concentration of the acetic acid in the condensate reaches 10 per cent., part of the condensate must be removed and the hydrochloric acid separated from the acetic acid.

The sirup from the distillation apparatus, containing approximately 55 to 65 per cent. of sugar, is dried by hot air. The sirup is injected, together with compressed air, through a nozzel. The hot air is blown into the shaft of the evaporator, whence the solid sugar in finely divided form, enters a cyclone in which separation takes place. The dry sugar drops into the bottom of the cyclone separator, and is drawn off while the air containing water and hydrochloric acid gas leaving the plant is washed. The rest of the hydrochloric acid is recovered in an ordinary absorption plant. The more or less diluted condensates and solutions of the hydrochloric acid are used in the same way as the distillate of the process, with the result that a very large percentage of the acid is recovered. Hydrochloric acid is lost only by retention of small quantities in the lignin and sugar. The lignin must be washed as free as possible from acid, so the loss is only about 5 per cent. of hydrochloric acid, calculated on the sugar produced, and the sugar contains about 2 per cent.

The process now used is a very simple one. Neither reaction vessels, pumps, conduits, or buildings are attacked by the acid, nor the workmen annoyed by acid vapours. It took a vast amount of experimental work to find the right form of the apparatus and the proper constructional materials.

The lignin can be used directly for heating purposes in the process, and can be briquetted without the addition of a binder. Such briquets have a calorific value of 5,000 calories, or approximately 9,000 B. t. u. per pound, and form a clean and convenient household fuel. From these briquets a pure and hard charcoal can be obtained.

The sugar, in the form in which it leaves the hot-air drier, contains about 2 per cent. of hydrochloric acid, a small percentage of inorganic compounds from the wood, and some moisture. The content of reducing sugars is approximately 90 per cent. Ony a small part of the sugars is present in the monomeric form, the largest part being polymeric. During the passage of the sugar from the battery to the atomizer, the percentage of tetrameric sugar is increased. According to Dr. Bergius, this polymeric sugar can easily be transformed into monomeric sugar by inverting it in a 20 per cent. solution a little above the boiling point. The sugar from conifers contains, besides glucose, especially mannose and pentoses ; the sugar from foliaceous

trees, chiefly pentoses in addition to glucose. Mannose and pentoses are the products of hydrolysis of the hemicellulose which can easily be extracted at relatively low temperatures from the wood by dilute acids. The German chemists have worked out a special process for this purpose. The hemicelluloses are saccharified and extracted by treating the wood, before it is brought into the drier, with very dilute acid. The pre-extracted wood is then dried and brought into the battery. This process allows the recovery of pure xylose free from glucose in crystallized form.

The raw sugar in its primary form can, after neutralizing, be used as a carbohydrate cattle food. It must undergo inversion before it can be fermented, but this inversion is a very simple and inexpensive process. To produce alcohol, only the hexoses can be fermented, so that 100 kg. of reducing sugar yield about 52 litres of 100 per cent. alcohol ; normal cane sugar yields about 60 liters. Other fermentation products, such as lactic acid, can also easily be produced from this product.

During recent years chemists have found a method for crystallizing pure glucose from the inverted solution of the raw sugar. This appeared a very difficult task in the beginning, and it took them a number of years to develop the crystallization process to its present simple form. The crystallized glucose can be obtained either in an anhydrous form or containing water of crystallization. The product is chemically pure.

(*Industrial and Engineering Chemistry, News Edition, Vol.* 12, *No.* 7, 10*th April* 1934.)

CAUSES OF BRITTLENESS IN WOOD.

For many purposes, one of the most serious defects that may occur in timber is brittleness. By brittleness is meant the tendency to break suddenly with little deflection and pratically no warning.

It is well-known that certain species of timber are much more brittle than others. Softwoods, *i.e.*, woods without pores, are in general less tough than hardwoods, *i.e.*, woods with pores. Variations within species are often so great, however, that some of the wood from normally tough species is more brittle than the wood from species which are normally low in toughness. Thus, species selection is often less important than the selection of individual pieces.

In order to make a judicious selection of tough material, it is necessary to know the various causes of brittleness, of which the following are the most usual in timber, state the Australian Division of Forest Products in their monthly bulletin :— (*i*) sloping grain, (*ii*) decay or rot, (*iii*) low density, (*iv*) rate of growth, (*v*) sapwood in comparison with true wood, (*vi*) compression wood, (*vii*) compression failures (*viii*) position in tree, (*ix*) heart, (*x*) high temperature treatments.

Sloping Grain.—This term covers cross grain, diagonal grain and spiral grain and all of these have been shown to be a definite cause of brittleness and one of the most common. A slope of 1 in 20 reduces the impact strength about 15 per cent., while a slope of 1 in 5 causes a reduction of about 66 per cent.

Decay (rot).—This is caused by the action of wood-destroying fungi and the toughness of decayed wood is very considerably reduced in comparison with sound wood of the same species. Even in the incipient stages, when the infection is not visible to the naked eye, the wood may be quite brittle. In the more advanced stages the wood, besides being seriously weakened otherwise, is incapable of withstanding even slight shocks.

Low Density.—In general, low density wood is more brittle than that of high density. It is found, therefore, that a piece which is much lower in density than the average for the species is usually brittle. On the other hand, wood of average density from a normally light species is usually tougher than the abnormally light wood of a heavier species, although the density of the latter may be greater than that of the former.

Rate of Growth.—This may have an indirect influence on the toughness of the wood; for example, in softwoods, in general, the higher the rate of growth the lower the density and, therefore, the lower the toughness; but in many hardwoods within limits fast grown wood is denser and tougher than slow grown. This does not apply, however, to the fast grown wood found near the centre of most trees, which is low in density and, therefore, more brittle than the average.

Sapwood.—No systematic difference has been discovered in the brittleness of sapwood with comparison to true wood. If of the same density and rate of growth, the toughness is about the same. On the other hand, under some conditions, growth factors may be such that the sapwood is of different density to the true wood and in such circumstances may have different properties to the true wood.

Compression Wood.—This is only encountered in softwoods and is a frequent cause of brittleness in these woods.

Compression Failures.—The toughness of wood can be seriously reduced by the presence of compression failures (transverse shocks or felling shakes), which appear in the form of lines running across the grain of the wood. These failures are caused by mechanical stressing due either to severe wind storms or to felling.

Position in Tree.—It appears that it is not advisable to use wood from too near the base of the tree when shock resistance is an important factor.

Heart.—In a large number of the eucalyptus the wood from near the centre of the tree is usually very brittle, and this part of the tree has been termed the "heart," which appears to be much more extensive in older than in young trees. The fundamental cause of heart is still unknown.

Heart may be readily detected by splitting off a small splinter ¼in. square and breaking it in the fingers. If the break is sudden and a carroty fracture obtained, the wood is almost certainly heart. If, on the other hand, the break is not sudden and a splintering fracture is obtained, the wood is true wood. Another method of detection that has been applied is to raise the grain with the point of a knife. If the silver runs along and is difficult to break the wood is almost certainly tough, but, if it breaks suddenly with a carroty appearance, the presence of heart is indicated. This test-

cannot be applied to the quarter sawn faces of timber with interlocking grain, and it is only practicable in the case of harder timbers when green wood is used.

High Temperature Treatments.—Long exposure of timber to high temperatures will cause brittleness particularly if the moisture content is high.

(*Timber Trades Journal, April 21st*, 1934.)

SOIL TEMPERATURES AND EVAPORATION.

The following data were obtained during the summer of 1932 in a 50-year old stand of paper birch, *Betula papyrifera* Marsh, and white pine, *Pinus strobus*, L., on the northern shore of Long Lake, Hamilton County, New York, at an altitude of 1,640 feet. The open station was located in a small opening about 200 feet back from the lake shore and 25 feet above the lake surface. It was exposed to full overhead light and to the sun about seven hours a day. The woods station was located 500 feet farther inland under a complete canopy of paper birch, white pine and balsam fir, *Abies balsamea* (1). Mill.

Soil temperatures were measured by ordinary chemical thermometers enclosed in hollow wooden stakes provided with ventilation holes opposite the thermometer bulbs. The stakes were driven in vertically until the position of the bulb was one foot below the surface. The exposed part of the stake was painted white, and the cork from which the thermometer hung fitted into a projecting white wooden cap.

TABLE I.—*Weekly averages of temperature in degrees Fahrenheit, evaporation in cubic centimeters per week.*

Dates, 1932.	Open.				Woods.	
	Rainfall inches.	Air Temp. 7 a.m.	Soil. Temp.	Evap.	Soil Temp.	Evap.
June 27 to July 3. ..	0.	..	59·1	93	54·3	53
July 4—10	3·12	57·9	59·2	70	53·0	28
July 11—17	0·41	56·8	62·0	115	55·1	58
July 18—24	2·67	56·5	63·0	96	55·6	45
July 25—31	2·62	58·8	63·3	75	56·4	17
August 1—7	1·21	57·9	62·7	80	56·4	18
August 8—14	1·46	56·3	62·4	72	57·5	33
August 15—21	1·18	57·7	62·3	76	56·5	22
August 22—28	·78	56·3	62·0	72	56·5	37
Totals ..	13·45	458·20	556·0	749	501·3	311·0
Average ..	1·49	57·2	61·8	83·2	55·7	34·5

Evaporation was measured by standardised Livingston spherical atmometers, exposed six inches above the soil. They were fitted with Livingston-type non-absorbing mountings and filled with distilled water. The atmometers were filled at weekly intervals, and soil temperatures were read at 7 a.m. daily. At the open station air temperature and rainfall were also recorded daily at the same hour. Evaporation followed much the same trend within the forest and in the open during the first half of the summer, but thereafter the relation was reversed. There was an obvious connection between rainfall and evaporation, but no direct relation between evaporation and soil temperature was apparent.—(*Henry I. Baldwin in Ecology, January* 1933.)

A RIVER PHYSICS LABORARTORY FOR INDIA.[1]

There are many lines in which the Government of India as well as the provincial governments can profit immensely if they take the trouble of obtaining proper scientific guidance before launching on large-scale enterprises. As many such cases are not known to all, I would refer to only one. Year after year the Government and other public bodies spend an enormous amount in constructing bridges and water reservoirs, in opening canals, in development schemes, in hydro-electric schemes and in city drainage schemes. These schemes are certainly highly beneficial and undertaken with the best of intentions, but from time to time, very unpleasant facts leak through the columns of the news agency, which show that these schemes are mishandled at some stage or other. Every scientific man knows that before the actual working commences the plans should be scientifically studied in Hydraulic Research Laboratories, with the aid of models, and the engineers in charge of constructions should have a clear-cut idea of the work before they are put in charge of it. In spite of the fact that next to the United States of America, India is the country which has undertaken such works on the most gigantic scale, and has spent hundreds of crores of rupees on these works, the Government has not yet thought fit to establish a single Hydraulic Research or River Physics Laboratory in this country while in other civilised countries no such enterprise is allowed to be undertaken unless the plans are examined in suitable laboratories attached to the Universities, Technical High Schools, or State departments with the aid of suitable models. To convey the idea of how such work is carried out in India, I have quoted the opinion of the late Sir F. Spring, an eminent engineer, who constructed a large number of railway bridges in India during the last generation and I would request my readers to read this very carefully. I should merely add that I am not against the launching of the schemes; in fact many of them, like the Punjab Canals, have done immense good to the country. But others like the Orissa and Midnapur Canals were constructed on faulty lines, and involved the State in huge financial losses; while other schemes like the laying of railway lines through major parts of Bengal without a proper examination of topography and of the river systems have plunged the country into perpetual outbreaks of malarial epidemics, and led to the sapping of the vitality of the population.

[1] From the Presidential Address to the Indian Science Congress (Bombay), 1934, by Professor Meghnad Saha, D. SC., F.R.S.

I do not hold that either the engineers or the officials are responsible for these failures and disasters. In fact, I think that most of them like Sir F. Spring tried to make the best use of a bad situation. But the fault is due to lack of imagination on the part of those who have taken upon themselves the task of Government and to their failure in devising a proper system of co-ordinated work in which preliminary scientific study in suitable laboratories should form an essential part of the organisation.

The Absence of any Organisation for Recording Experience or Research in connection with the Physics of Great Rivers.[1]

"As trustees of so fine a property as this—canals and railways—it might not unreasonably be expected that the State would see the importance of devoting a comparatively small annual appropriation to original research, on lines likely to be productive of a good return for the expenditure, in the form either of reduction in the first cost of its public works or of their safety and their economical upkeep when built. Heretofore there has been no pretence of organising any such research in connection with the engineering of the canals and railways of India. Engineers have gone on blundering, benefiting, rather by chance than by design, by the experience of their predecessors, and each considering himself lucky if he escapes disaster at the hands of the tremendous forces of nature—amongst which some of the most potent for good or evil are the great rivers—with which he has to struggle. Until quite recently there has been practically no encouragement, and indeed at times there has been discouragement to men to publish their experiences. And so, in spite of having perhaps as fine a body of scientific engineers as any country, not excluding France, has in its employment, and in spite of this body of public servants having carried out daring and extensive works of a certain character, chiefly, in connection with the great Indian rivers, on a scale unparalleled elsewhere, the State possesses the most meagre record of the history of the works carried out so successfully by its employees. In putting the chapters of this book (*River Training and Control*, by Sir F. Spring) together, the author found extreme difficulty in ascertaining what had been done, what difficulties had been encountered, and how these difficulties had been surmounted, and it has needed the expenditure of nearly a year of research to enable him to offer to the Government of India the advice, contained in the foregoing chapters, in regard to one limited phase of the engineering of great rivers. Time will show the value of that advice, and doubtless further experience will modify the practice recommended. But meanwhile the author urges on the Government the importance, from a mere money point of view, of insisting on the maintenance of an intelligent record of the history of such works as those dealt with in the foregoing chapters."

The Consequences of Lack of Organisation.

2. "With regard to the physics of long reaches of the great rivers, the author is not in so good a position to speak. His special experience has been gained rather on short lengths of such rivers in contiguity to his works. In view of his practical inability to regulate the flow of great lengths of such rivers he has viewed the inimical consequences of the irregularities of their flow, in the form of deep and dangerous

[1] Opinion of Sir F. Spring on the need for a River Physics Laboratory quoted by Professor Meghnad Saha, D.SC., F.R.S.

scour, as requiring to be fought by sheer irresistible force rather than by coaxing. This necessarily must be the attitude of the engineer in charge of great bridges, and perhaps to a lesser extent of those in charge of great irrigation weirs. But they ought not, for that reason, nor ought the State, to lose sight of the importance of endeavouring, by consistent, logical and well organised research, to learn something more definite than is now known about the physics of long reaches of rivers. A perusal of Chapters III and XXI, as well as of Mr. R. A. Molloy's Technical Section paper No. 118, will suffice to show how blindly, heretofore, in the interests of the residents on their banks, men have been fighting against the ill-will of some of the great rivers ; whether on behalf of the maintenance of levees[1] whereby devastating floods are excluded from great inhabited areas ; or for the conservation of the lands of inundation canals on whose integrity the welfare of many thousands of people is dependent ; or in the interests of riparian cities whose obliteration would be a blot on the administration of civilised and intelligent rulers. It is difficult to avoid the conclusion, after perusal of Chapter XXI, that for lack of adequate knowledge, the engineers concerned with the interests of the inhabitants of the valley of the Indus have been obliged to work more or less in the dark in their fight with that river, and to make matters worse, it has constantly happened that owing to the climate, to the exigencies of public service, no sooner does one engineer get some small inkling of the tricks than he is replaced by one with all his experience to gain : and in six months he, in turn, is replaced by somebody else whose experience of the river has perhaps been limited to crossing it. How under so haphazard a system, anything gets done at all is a marvel and instead of being surprised at £100,000 worth of work having been wiped out, the State may congratulate itself if the loss is not double. However, there is always the satisfaction, in the case of such expenditure as that dealt with in Chapter XXI, that the whole of the money has remained in the country, and that if the tax-payer takes money out of his coat pocket only to put it into his waistcoat pocket, he can always pick it out again, or its equivalent.

Suggestion for the appointment of a River Commission.

3. " The appointment for, say, 10 years of a River Commission not merely for the Indus, but for the organised study of the physics of great alluvial rivers generally, would be a service to civilisation and an act worthy of a great State. The Mississippi Commission have done a great deal, but their experience is not to any great extent applicable to Indian conditions. The experience of the engineers of the Rhone and the Danube and other European rivers, though valuable in its way, is even less applicable to India than that gained on the Mississippi. Mr. R. A. Molloy's attempt at a theory, as summarised very inadequately in Chapter III, is the first that can be characterised as a scientific generalisation of the river problem that the author has heard of in India. And even this is based on inadequate data, picked up anyhow amidst the multifarious duties falling to the engineer to a system of inundation canals. There is need for a thoroughly scientific location, and for the automatic reading of gauges at hundreds of places, for several years, along great lengths, selected with care

[1] This is a word of French origin, which is used in the U.S.A. to denote embankments.

and knowledge, of several of the great Indian rivers, also of some systematisation of the surveys which usually are undertaken on these rivers, and of the making of fresh surveys specially designed to elucidate facts also of an organised system of soundings and sections. The engineers in charge of the work must steadily keep in view the ultimate object of it, and must not make a survey merely for the sake of a section. The object in view will be: To present to the scientific world, and especially to the engineering world, and more particularly to the engineers of structures in India that are subject to fury at the hands of the great alluvial rivers, under various circumstances as will allow of such action being anticipated; and especially to enable the engineer to utilise fully his knowledge of the rivers, so that he may make a servant of it, instead of being as it is now very often the case, his master. There can be no doubt at least from the author's point of view that more money has been wasted, for want of just such knowledge as a River Commission might provide, than would have sufficed to pay the entire cost of it many times over. Certainly, so far as training works in connection with bridges are concerned, in rivers of the class with which the author has chiefly concerned himself, most engineers responsible for such works would probably admit that whether they spent money unnecessarily as an insurance against their inevitable lack of scientific data, or that they were unduly economical with either disaster, or heavy annual recurring expenditure in after years, as the result. Thus looked on from the lowest or merely commercial standpoint, the establishment of such a Commission ought to be highly remunerative."— (*Current Science, March* 1934).

INDIAN FOREST PRODUCTS.

The principal tanning materials are myrabolans, termeric, gambier, cutch and divi-divi, of which myrabolans are the most important. Owing to the expansion of the Indian tanning industry, their consumption has increased lately, but still a large surplus is available for export. On an average, India now exports annually about 75,000 tons of all tanstuffs, of which myrabolans alone form 80 per cent. Nearly half of the exports are usually taken up by the United Kingdom, and a fifth by the United States of America; Germany is the next best buyer. The source of shellac is another important Indian forest product. It is formed by a diminutive scale insect which infests certain trees, drawing the sap from them, and exuding it in resinous form as a 'scale' or protection against its enemies. The crude or stick lac, after collection from the tree, is broken up and washed in water to form the seed lac of commerce. In this form, it is being exported in increasingly large quantities to Europe and America for manufacture into bleached lac and varnishes. Shellac and button lac are made in India by a heat-fusion process from the seed lac: 80 per cent. of the annual exports are still in this form. The United States of America is India's largest customer for lac products, followed by the United Kingdom, then Germany and other countries. The principal uses for lac products are in the manufacture of gramophone records (40 per cent.) electrical and other varnishes and polishes (40 per cent.) in the hat-hardening trade (10 per cent.) and in a large number of miscellaneous trades (10

per cent.). Lac products have had to undergo in recent years serious competition with nitrocellulose and other synthetic substitutes. A Lac Research Institute has been founded in India to conduct research in the natural product, and a special officer has been appointed in London, with headquarters at India House to investigate and stimulate the demands for lac and shellac. The annual export trade amounts to roughly 30,000 tons in volume, and 2½ million pounds in value. Finally, in her coniferous forests extending along the Himalayas, India possesses a valuable supply of softwoods, required entirely for home consumption, while an intermediate product is represented by the crude resin of certain pines, which are manufactured into rosin and turpentine. India has two large turpentine factories, one in the United Provinces and one in the Punjab. The latter, the outcome of considerable research and laboratory work, is the largest resin factory in the world, equipped with the most up-to-date machinery. The products are graded to conform to the world-wide accepted American standards. This industry has made India independent of foreign rosin and turpentine supplies, and a small export trade has been built up. This trade will develop, as roads and other transport facilities make the belt of pine forests more accessible. —(*Engineer of India*, *March* 1934).

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SEPTEMBER, 1934.

RETRENCHMENT IN BURMA.

In Chapter V of their report the Retrenchment Committee deal with the Forest Department : the goose that lays the golden eggs, but which lately has been laying rather poorly. Before the appointment of this committee a considerable reduction of staff amounting to 3 Conservators' posts, 9 territorial divisions, 4 working plan and 4 research posts had already been made. The cadre of Class I which stood at a strength of 119 was reduced to 91 and 7 officers were axed. However the masters of the goose have demanded more with the final result that the premier forest province of the British Empire which has provided a surplus of 1 crore of rupees in the past and might easily do the same again in prosperous times, is to be further reduced. The Working Plans Conservator who is responsible for the whole technical management of the forests of Burma is to go. This post which has been held by some of the foremost foresters whose names are known professionally throughout the English speaking world, is in the committee's opinion no longer required and they consider the work can be done by any odd Deputy Conservator seated in the Chief Conservator's office and by any divisional officer whether he knows anything of working plans or not. We wish to point out that according to the latest annual report on working plans for Burma, working plans for 8,814 square miles are due for revision within the next three years. With an emaciated executive cadre how is this work going to be done ? To continue the story :— The number of Conservators is reduced to 5, the territorial divisions to 33, the Botanist and the Silviculturist disappear, and the Class I Service is reduced to 66 officers against 89 at present employed. 23 officers will therefore have to go. Class II which previously stood at a strength

of 100 posts is now to be reduced to 60. After this severe course of treatment, will the goose ever have the energy to lay again?

We are not surprised to find these proposals very severely criticised by Mr. Richards at a meeting of the Burma British Association as reported in the *Rangoon Gazette* of July 18th. Mr. Richards' words are as follows:—

"The determination with which the Committee pursued its unpleasant task may lead to wrecking the Forest Department, in which an annual saving is proposed of over Rs. 12 lakhs. Without a critical examination covering a wider field than that surveyed by the Committee's Report, we cannot believe that this department has been so extravagantly managed in the past that, in addition to the retrenchment it has itself already adopted, a further Rs. 12 lakhs a year can now be saved without doing irreparable damage to one of the Province's greatest assets.

"It is recommended that 23 posts in the Class I Service be abolished. Class I is the brains and experience of the Forest Department and if it is annihilated, forests will inevitably decay. Once the present officers in this class are removed, their places will never again be filled by men of their calibre and their industry.

"Extravagances of the past probably had their origin in a superabundant establishment but reducing it to the skeleton recommended by the Committee will imperil the enormous timber resources of the country whose conservation and regeneration is the department's proper function.

"In submitting certain proposals early in this chapter it is recorded that the Chief Conservator has emphasised that they are not his recommendations, that they are bound to involve loss of efficiency and to react adversely on the provincial forest estate. Later on it is stated that on the understanding that the need for financial retrenchment is paramount and that temporary loss of efficiency has to be faced, he is prepared to make further reductions. It seems to us that the Chief Conservator was put through the 'third degree' and thus acquiesced in unsound proposals and suggested reductions which effect no real saving."

"Great as the revenue is which the forests have produced in the past, their indirect value is incalculable, as forestry is work for which the rural Burman has a natural adaptability, a vocation in which he is happy and one in which Burman and Britisher have worked together to great mutual advantage since the time before Burma was part of the British Empire. Are we going to sacrifice this to the financial necessity of a year or two ? We claim that many of the recommendations, great as the financial necessity is, should be examined again, not in the light of the immediate financial position of the Province, but from the long-term aspect of what value the forests are likely to be to Burma in the future. When that is established we can embark on reductions with a confidence which cannot be felt at present."

To anyone who has the interests of forestry at heart, what amounts to a complete abandonment of silvicultural research and the destruction of a carefully planned organisation for working plans appears as a policy dictated not by reason but by panic.

We are perfectly well aware of what the results of this policy will be in years to come, when all the knowledge which now reposes in the best brains of the service will have been lost. Working plans will be turned out on stereotyped lines, one the same as another, without the guiding hand of one who knows everything there is to be known of the tree species of Burma and whose life has been devoted to the elucidation of problems of growth and yield. Forestry instead of being alive and active will deteriorate into dull routine and all the progress of the last 30 years will disappear. We have great experience of such an organisation or rather total lack of organisation, where any member of the staff is ordered to go and make a working plan and be quick about it ; and our considered opinion of such methods are that they are beneath contempt. What appalling silvicultural failures, what great financial losses have been due to working plans prepared by persons without full knowledge of their subject.

Let anyone compare the state of any province with a proper working plan organisation before and after the institution of such an

organisation, the difference is that between order and chaos. Our working plans are the envy of every colonial Forest Department, yet this Committee with no knowledge whatever of technical forestry thinks that the preparation of working plans can be carried out in the same way as the manufacture of sausages. Figures go in at one end and out comes the plan at the other. We are not opposed to reductions of staff necessary in these hardtimes, but when such reductions involve the elimination of the brains of the Forest Department it is really time to protest. Why not equally well abolish the general staff of the army and let every colonel make his own plan of battle.

Apart from the technical aspect of the matter what about the existing and accruing rights of members of the service guaranteed to them by the Government of India Act. Is this another scrap of paper?

FOREST HISTORY : ANCIENT AND MODERN

By R. S. Hole, C.I.E., I.F.S. (Retired).

According to the *Indian Forester*, Vol. 10 (1884), pp. 72—73, Sir J. Lubbock is reported to have informed the House of Commons that "it was he feared still true that, as the House of Commons' Committee of 1854 reported, timber is everywhere worse managed than any other species of property. Unless something were done, this state of things would continue. On the other hand, the highest authorities had expressed a very strong opinion that we might make our woodlands much more profitable ; if we included our colonies, our forests were the largest and most valuable in the world."

On p. 95 of the same volume, in connection with the climatic and physical effects of forests, we find a quotation from another source to the effect that "Turkey, Italy, France and Spain, have all suffered severely from denudation due to the destruction of the forests which once clad their mountain slopes, and historians have attributed the decadence of Spain largely to this cause. The barrenness of the once fertile Palestine, of Syria and of Cyprus has been brought about in the same way."

On p. 312, we read "that there is a general and widespread opinion throughout the colony, that the destruction of forests within

the last few years has had something to do with the change for the worse, which is universally believed to have occurred in the climate of Cape Colony."

On p. 340, "We are told by a traveller how the introduction of goats into St. Helena utterly destroyed a whole flora of forest trees."

Turning now to the *Indian Forester*, Vol. 12 (1886), on pp. 221—222, we find an account of some evidence given by the Director of Kew Gardens (Mr. W. T. Thiselton Dyer) before a Select Committee of the House of Commons in which he is reported to have said : "When a colony, for example, in the condition of Honduras, which has been very little opened up, is first occupied by planters, a great part of the surface is naturally covered with forest. For a very long time that forest can be drawn upon ; in fact, it may be used up and even destroyed, without attracting any great attention ; but there comes a point when the denudation of the forest reaches the highlands, and especially in tropical countries, when the banks of rivers are denuded, that the water supply begins to fail, the rivers begin to dry up, the hot winds are let into the lowlands from denuding the ridges, and a variety of changes in the physical conditions begin to force themselves upon the attention of the residents. Then for the first time it dawns upon them that the destruction of the forest has either gone too far, or is within measurable reach of doing so."

In the *Indian Forester*, Vol. 24 (1898), p. 5, we find Dr. Schlich stating, in connection with the training of the forest students at Coopers Hill, "Last but not least, they become acquainted with and are thoroughly impressed by the beneficial effects of long continued systematic management and undisturbed *continuity of action*. The latter is of special importance to men, who have to work in India, a country where the Government officers change so rapidly, and where every new broom is so much inclined to sweep away what its predecessor has done, and to start afresh again." On p. 244 of the same volume also, in an address given by Dr. Schlich before the Royal Scottish Arboricultural Society, we find the remark : "Of course we must not forget that this is a century which marches ahead at a quick

pace, while forestry is an industry which proceeds but slowly. Haste has no place in forestry."

Passing now to a more recent publication, *viz.*, *The Review of Applied Mycology*, issued by the Imperial Mycological Institute, Kew, Vol. 13 (part 4) for April 1934, on pp. 220—222, we find some interesting notes regarding a paper by O. F. Kaden, published in *Der Tropenpflanzer* of 1933, concerning diseases of cacao in St. Thomas and Prince's Islands. In connection with the disease termed "morte subita" in St. Thomas Island, the gradual modification of the insular climate is especially emphasized "largely under the influence of the excessive deforestation and drainage of swamps to meet planting requirements. Formerly enjoying a temperate moist warmth throughout the year, the island is now subject to sharply fluctuating extremes of temperature and humidity to which cacao is naturally sensitive. The importance of this factor in the causation of "morte subita" is suggested by its complete absence from Prince's Island until 1929, when large forest areas were cleared and the climatic conditions underwent the changes described above; at this time the first cases of the disease were recorded."

Another diseased condition referred to as 'mela' (yellow fruit) we are informed, also appears "to be primarily a sequel to abrupt climatic changes, and in the writer's opinion the associated fungi (*e.g.* *Lasiodiplodia theobromæ* and *colletotrichum luxificum*) are purely secondary." Other conditions referred to are precocity and hardening of the fruit, nanism or dwarfing and the dying-off of old trees, with the concluding remark that "the sole cure for these disorders is the restoration to the trees of the essential conditions of growth—good soil, humidity, shade, and protection from wind."

It seems almost as if some fundamental principles, even though they may be ancient, cannot safely be ignored even by the modern world.

LONDON,

May, 14*th* 1934.

EUCALYPTUS NAUDINIANA.

By C. G. Trevor.

This Eucalypt is one of the few species of this family found outside Australia. It is found in Celebes, Moluccas, New Guinea and the Bismark Archipelago and is also found in the Phillipines in well drained places along streams up to 1,800 feet. It is a handsome tree with broad foliage. Some seed of this species was received in India from the Secretary, Commonwealth Bureau, Canberra. The following notes by Messrs. J. A. Wilson, District Forest Officer, Chittoor, and C. E. Parkinson, Forest Botanist, Forest Research Institute, regarding its cultivation in India are of interest :—

A small packet of *Eucalyptus naudiniana* seeds was sent by the Secretary, Commonwealth Bureau, Canberra, and the same was ordered to be tried in the Palmaner Rest House compound, Madras.

A pit $10' \times 3' \times 6''$ was dug, all the earth taken out was sterilised in small quantities by frying in an iron pan placed over an oven. After all the soil had thus been sterilised, it was mixed with equal parts of carefully mixed sand, loam and garden humus and the whole mixture was put back so as to form a seed bed. As a result the level of the seed bed was 6″ above ground level.

The seeds were sown on 28th June 1933 by the District Forest Officer by mixing them with fine sand and gently scattering the mixture on the surface of the bed. The bed was then covered with a thin covering of straw and watered immediately, and watering was kept on regularly both morning and evening.

The seedlings were first enumerated on 29th August 1933 and 110 seedlings were observed by the Range Officer. These seedlings were again enumerated by the District Forest Officer on 14th October 1933 and 102 seedlings were well developed, the tallest being 9″ high. The seedlings were spreading laterally and occupying much space. 21 crowded small seedlings were pricked out at one foot apart in the bed. 12 seedlings were carefully pruned with scissors of their lateral branches, and later all seedlings were pruned in November 1933.

The seedlings were transplanted into baskets by the Ranger on 6th January 1934 and will be put out under forest conditions this year in Whitesides Garden. Three seedlings were transplanted with balls of earth adhering to the roots in Palmaner Rest House compound. Despite their having been browsed by a goat which got into the compound, the tallest is now 3′ 6″ high and very healthy. The other two are still alive but are more or less existing. One seedling left in the original seed bed is 2½′ high and very healthy. Seedlings in baskets average 1′ in height and are mostly healthy.

Eucalyptus naudiniana was first tried at New Forest, Dehra Dun, in 1929. Seed obtained direct from New Guinea was sown in June of that year in ordinary seed boxes and watered with a fine spray. Germination was very poor, (no count was made for germination percentage), many of the seedlings damped-off and growth was slow. The few surviving seedlings were transferred to pots in March 1930. Further sowings were made from the same lot of seed in August 1929 and February 1930, but no germination occurred.

The best of the survivors from the first sowing was planted out in the experimental garden near a water tank in April 1930 and it has since grown well. In August 1931 it had attained a height of about 8′. It flowered as early as June 1932 and again in 1933 and 1934, and the seed produced has proved fertile though a high percentage of germination was not obtained nor was it expected. The tree is now 35′ high.

A further lot of seed was supplied to us for trial by the Secretary of the Commonwealth Forestry Bureau, Canberra, Australia, in June 1933. About half of this was sown in July of that year. The Changa Manga method of raising Eucalyptus—described in the *Indian Forester* for 1932, pp. 211—220, was more or less followed. The seed was sown in a sifted humus soil mixed with sand in 9″ pots which were placed in a trough in the ground and flooded to within an inch or two of the top of the pots, percolation taking place from below. The seed germinated freely and no damping-off occurred. About a month after germination the seedlings were transferred singly to fresh pots; they

are now about 6″ to 10″ high and are being planted out in the New Forest grounds.

A further trial with the remaining lot of seed obtained from Canberra was made in April 1934, the Changa Manga method again being followed, but no germination occurred; it appears therefore that the seed of this species soon loses its germinating power.

It is difficult to say whether the failure in 1929 and success in 1933 was due to a fresh stock of seed or the different method adopted; it was probably due to both these factors.

SABAI PLANTATION IN POOR QUALITY SAL FOREST.

By F. C. Osmaston, I.F.S., Forest Research Officer,

Bihar & Orissa.

Sabai grass (*Pollinidium angustifolium*) is one of the commonest grasses in the sal forests of the Singhbhum district of Bihar and Orissa. It generally seems to avoid dry mixed deciduous forest, but is found in nearly all dry types of sal forest and is generally commonest where the sal crop is open and of very poor quality and where the soil is shallow and dry overlying quartzite and shale. This grass is not only used locally on a large scale for the vigorous cottage industry of string and rope making, but is also exported in large quantities for paper making to Ranigunj. The annual revenue received is large, that is to say over Rs. 20,000/- annually, so experiments were begun in 1925 to see whether it would be easy to propagate the grass artificially, and considerable success has been obtained.

An area of 10 acres in the Saitba Range of the Kolhan Division was chosen when there was a very poor, dry type of sal coppice forest on a shallow quartzite and shale soil. The ground is steeply undulating. Spear grass (*Andropogon contortus*) was a common grass as well as *sabai*. The undergrowth included species like *Gardenia gummifera*, *Diospyros melanoxylon*, *Zizyphus oenoplia*, *Helicteres isora*, *Indigofera pulchella*, *Holarrhena antidysenterica* and *Phœnix acaulis*.

In November 1925 all growth was clear felled to be burnt in March—April 1926, after piling the debris on stumps. Before the 1926 rains broke, the area was thoroughly weeded by uprooting shrubs and herbs and cutting back any coppice re-growth. At the break of the rains roots of *sabai* grass were planted in lines and spaced $3' \times 3'$ by dibbling in roots broken off from large clumps. Failures were replaced 3 or 4 weeks later and the area was kept thoroughly weeded. Experience has shown that to avoid casualties in planting work, the ground must be thoroughly damp and the *sabai* rootstocks must be put out in rainy weather. A break in the rains just after planting causes many casualties. So far we have not yet tried sowing, an objection to this method being the minuteness of *sabai* seed and the labour entailed in its collection.

It has been found that the following annual work gives good results. The grass is harvested in November—December annually. In April or May all growth (*sabai* or weeds) is cut and burnt. One weeding is made during the rains in August, and in this weeding it is economically preferable to cut back all weeds than to uproot them, but that not to weed them at all gives definitely poor yields, as the following figures show :—

Average yield per acre per annum in the unweeded area ..	14·9 Mds.
Average yield per acre per annum when weeds are uprooted	31·5 ,,
Average yield per acre per annum when weeds are cut ..	29·8 ,,

(*Note.*—These figures cannot be taken as absolute owing to lack of duplication and possible lack of complete comparability of the areas treated).

No manuring of any kind hasbeen made so far, but there are signs that the yield per acre is now falling off. Yields of 20—25 maunds per acre can be expected 3 years after planting and so far the yields in our weeded plots remain at 27—30 maunds per acre without manuring as the table of yields given below shows.

One interesting fact that has emerged is the willingness of *sabai* grass to seed. After harvesting in December it flowers and seeds 2 or 3 months later. But on being cut and burnt in May it again flowers

and seeds in early June. In consequence there is considerable natural regeneration. This eagerness to regenerate shows that it is probably unnecessary to plant closer than $3' \times 3'$.

Costs of formation, that is to say all the first year's costs, seem to be about Rs. 20/- per acre. Annual costs are roughly as follows :—

Burning	..	Rs. 1/8/- per acre
Weeding	..	Rs. 3/8/- per acre
Total	..	Rs. 5/- per acre or about -/3/6 per maund

for a yield of 25 maunds per acre.

The cost of harvesting and delivering, F. O. R., 8 miles away are about -/8/- per maund, making a total annual expenditure of -/11/6 per maund for grass, F. O. R. At present we receive 1/1/- per maund for grass, F. O. R., leaving a profit of -/5/6 per maund. As the yield per acre should not be below 25 maunds, this gives a profit of Rs. 8/9/6 per acre per annum, excluding overhead charges, which is very good for this poor quality land and very much better than a tree crop could give.

Many may argue that it is not forestry to cut down trees and plant grass even if grass is more profitable. No doubt all foresters will feel this. On the other hand is it a wise point of view. In Singhbhum any way there are large areas of very poor sal forest on hill tops incapable of producing trees over 40′ high and they are usually unsound. In other words, a tree crop on these hills can only be grown for protective value. In this experimental *sabai* plantation in Kolhan no erosion is apparent although it has been in existence for 8½ years on steep undulating land. Why therefore should *sabai* not be used as a protective crop on these hills ?

On the other hand it can truly be argued that owing to competition of bamboos with *sabai* for paper making, the price for *sabai* grass may fall to very low level. In Singhbhum any way we grow normally 1,00,000 maunds per annum. Is it worth increasing these yields ? On the whole I think not, if to do so forest has to be sacrificed. But if we find that by planting up fire lines with *sabai* the protective value of fire lines is not lost, then *sabai* plantations are an attractive proposition.

To summarise we have discovered that it is easy and profitable to make *sabai* grass plantations, annual burning and annual rains weeding being essential. We next propose to experiment in planting or cultivating *sabai* grass on fire lines to see whether the cultivated *sabai* nullifies the protective value of a fireline or not. We hope the protective value of a fireline will be improved. It is difficult, in fact impossible, without great expense to keep our firelines clean at present. With a *sabai* grass crop they will be cut clean twice a year and burnt in April—May, that is to say, just *after* the distressing fall of dry leaves that at present makes our firelines next to useless.

SUMMARY OF YIELDS.

Year.	Experimental Plot No. 13 Kolhan Division.								Experimenal Plot No. 20 Kolhan.		Remarks.
	Sub-plot (1).		*Sub-Plot* (2)		*Sub plot* (3).		*Total Plot.*				
	Total md. dry.	Md. per acre.	Total md. dry.	Md. per acre.	Total md. dry.	Md. per acre.	Total md. dry.	Md. per acre.	Total md. dry.	Md. per acre.	
1	2	3	4	5	6	7	8	9	10	11	12
1927-28 ..	..	..	..	..	..	..	70	7	..	..	
1928-29 ..	46½	15·5	77½	25·8	77	25·6	201	20·1	..	..	
1929-30 ..	36	12·0	101	33·7	94	31·3	231	23·1	..	..	
1930-31 ..	42	14·0	140*	36·6	56*	18·6	238	23·8	35	7	*These figures seem faulty.
1931-32 ..	51	17·0	111	37·0	101	33·7	263	26·3	110	22·0	
1932-33 ..	45	15·0	95	31·7	90	30·0	230	23·0	110	22·0	**Total 341½ maunds but railway weighments gave 362½, so the figures given are on the low side.
1933-34 ..	47½†	15·8	88	29·3	83½	27·8	219**	21·9	122**	24·6	†Weeds were cut this year.

NOTE.—At the present time there has been a great falling off in the sales of *sabai* grass in Saharanpur owing to its place having been taken by bamboo in the Calcutta paper mills. *Sabai* will no doubt always sell in certain quantities but to make extensive plantations of *sabai* at the present time does not appear to be financially wise. The planting up of firelines with *sabai* is an interesting experiment which some other provinces might like to copy. C. G. T.

A CENSUS IN TIGERLAND.

By J. W. Nicholson, I.F.S., D.F.O., Palamau Division.

For the last year or so I have been playing with the idea of attempting a census of tigers within our Government forest limits. To be successful an attempt of this sort can obviously only be carried out under hot weather conditions when water is scarce. Last year the hot weather was unusual on account of the amount of rain which fell and I decided that it was not worth while trying a census. This year the early hot weather proved particularly dry, and so, conditions appearing favourable, I fixed on May day as the date for a census. Not having had any previous experience of organising such a procedure, nor having read of any similar attempt having been made elsewhere, I decided that our first effort should be confined to the Southern Range of this division, 115 square miles in extent. My instructions to the Range Officer, Maulvi Mohammad Sharif Khan, were that arrangements should be made to employ men to visit every water hole and river in his range on the early hours of the morning of the 1st May; that the width of all pug marks should be accurately measured with sticks; and that the men should then bring in the sticks to the beat guard and inform him of the sex of the animal and the direction in which it was travelling. It was contemplated that there might be a risk of the same animal being measured at different water holes and so stress was laid on recording direction.

The Range Officer improved on my general instructions. He carried out a rehearsal on the preceding day and then had all old pug marks in the vicinity of water smoothed out. Fortune favoured us as on the night of the 30th April a slight shower of rain fell—the only one for several weeks. Conditions were therefore perfect for recording accurate pug measurements on firm soil. The results of the census are given below. Out of 84 water holes or rivers visited tiger pug marks were recorded in 32 places and in no case was there any chance of the same animal having been enumerated twice.

Size of pug.	..	*No. of males.*	*No. of females.*
7″	..	3	..
$6\frac{3}{4}$″	..	1	..
$6\frac{1}{2}$″	..	3	..
$6\frac{1}{4}$″	..	4	1
6″	..	3	..
$5\frac{1}{2}$″	..	3	..
$5\frac{1}{4}$″	..	1	1
5″	..	1	1
$4\frac{3}{4}$″	..	..	2
$4\frac{1}{2}$″	..	..	2
$4\frac{1}{4}$″	..	1	1
4″	..	1	..
$3\frac{1}{2}$″	..	1	..
$2\frac{3}{4}$″	..	..	1
$2\frac{1}{2}$″	..	..	1

The total of 32 tigers works out to an average of one per 3·6 square miles. In addition 3 panthers with 3″ pugs were enumerated. Our two biggest tigers, which measure 8″ and 9″ respectively, were not at home when the census took place.

The surprising feature is the low proportion of females to males and the absence of females with the younger cubs. It is possible that certain of the recorded males were actually females as cases of tigresses with manly feet do occur, and one tigress, whose measurements corresponded with those attributed to a male, was shot a few days later close to where the so-called ' male ' came under the censor's eye.

The cost of the census was Rs. 5/13/-, 93 outsiders having been employed.

As this trial census went without a hitch, it is proposed, provided that climatic conditions permit, to hold one annually for the whole division. I also intend that a special map should be maintained to show the results of each year's census, the localities where the tigers were enumerated being numbered in different coloured inks, according

to the year, and a key list maintained giving details of size, sex, and travelling direction.

Our forests are too mixed up with Zamindari forests for strictly comparable results to be obtained, unless we extend the sphere of the census operations to all forest areas, but we shall at least have some check on the natural regeneration of a forest product which has hitherto eluded the columns of Form 18 A or B.

A DEFECTIVE LOG OF *PAPITA* (*STERCULIA CAMPANULATA*, WALL.) FROM THE ANDAMANS.

By K. Ahmad Chowdhury, Wood Technologist,
Forest Research Institute, Dehra Dun.

While on tour in the Andamans, the Inspector-General of Forests came across a log of *papita*, which had been rejected by the Western India Match Company at Port Blair, for being very soft and unsuitable for match splints. A disc from this log and also one from a normal sound log were brought to Dehra Dun for a comparative microscopic examination with a view to finding out the cause of the defect.

On superficial examination, it was found that the defective log had extremely eccentric growth—the radius from the pith to the bark varying from 8" to as much as 23". The wood was, however, uniformly very soft throughout the section. It was therefore very doubtful that the eccentric growth was in any way responsible for the unusual softness of the wood. Then it was thought that the defective log might have had a faster rate of growth than normal timber. But on counting the rings, it was found that the difference between the defective log and normal timber was so slight that any such view could not be entertained.

Lastly on microscopic examination the following results were obtained :—

Normal specimens (from F. R. I. collection).	*Defective specimen.*
1. Extremely interlocked fibre.	Slightly interlocked fibre.
2. Ray width normal.	Ray width much above the normal.
3. Fibre mostly medium thick walled.	Fibre extremely thin walled.

From the above data it will be seen that the anatomical structure, which is responsible for the softness of the defective log, is its cell-wall thickness.

To verify this, the weight of this wood was determined, for it is mainly the cell-wall material in wood that gives weight. The oven-dry weight of normal *papita* varies from 23—26 lbs. per cubic feet, but in the defective timber, the weight was found to vary from 13—16 lbs. It can, therefore, be said that the softness of this defective timber is due to unusually thin cell-walls.

The final problem is to decide what has been responsible for the formation of such thin cell-walls in the defective log. From a microscopic examination it is not possible to give a reply to this question. Most probably it is due to some defective environmental and physiological conditions in which the tree grew in the forest, but it would be interesting to know if anyone can throw any light on this subject.

SOIL FLORA IN DEODAR FORESTS AND ITS IMPORTANCE.

By K. L. Aggarwal, i.f.s.

In recent years a good deal of attention has been devoted by foresters to the study of soil flora and its relationship to the growth of tree crops. This has further led to the sub-division of forests into "Forest Types." In India owing to the prolific number of species, it seems difficult to base "Forest Types" on soil flora. Working plans in the past have generally dealt with the subject of soil indicators and Mr. Glover in his paper "Some factors affecting Deodar Reproduction" (*vide* Proceedings of the Punjab Forest Conference, 1930) discussed it to a certain extent, but of late more attention has been paid to the study of "Forest Types" and it is understood that research is also being undertaken in this connection. The writer wishes to record the results of his observations regarding soil flora carried out in the course of 3—4 years' work in the high ranges of the Himalayas. The most important timber tree in the Punjab Himalayas is obviously the deodar (*Cedrus deodara*) and it is felt that observations which would to a certain extent help us in determining the

suitability or otherwise of locality for deodar would go a long way in avoiding attempts at trying the introduction of this species in localities where its chances are, on the face of it, very meagre. The deodar occurs at its optimum between an altitude of 6,500′—8,000′ above sea level in the moister region of the inner Himalayas where snow fall is fairly heavy but ascends higher in a drier climate or on southern slopes. It is also well recognised that it requires a well drained soil and avoids damp or swampy situations. Soil flora is of importance as indicating conditions regarding moisture, warmth and drainage etc. of the surface soil and it is the condition of the surface soil which is important in regeneration. In the course of inspections the writer has been struck by the presence of the following species in deodar forests which are constant through Kulu, Seraj and Lower Bashahr and the same typical flora is said to be present right through to Hazara. The tract dealt with in this article lies between north latitude 31° 6′ and 32° 36′ and east longitude 76° 59′ and 78° 26′ with an average annual rainfall of 40″—45″. The following are the principal species indicating favourable soil conditions :—

SHRUBS : —*Indigofera gerardiana*, *Rosa sericea*, *Lonicera quinquelocularis* and *angustifolia*, *Desmodium tiliæfolium* and *Rubus*.

HERBS :—*Fragaria*, *Geranium*, *Ainsliæa*, *Viola*, *Galium* spp. maiden-hair fern, bracken fern, *Anaphalis* and light grass.

Indigofera gerardiana. This is perhaps the most important associate of deodar and generally indicates suitable soil conditions for its regeneration. Sometimes however it takes complete possession of the ground and thereby inhibits regeneration from appearing.

Rosa sericea and *Lonicera angustifolia*.—These are generally always associated at elevations of about 7,000′ and over, but go almost up to the limit of tree growth. *Lonicera quinquelocularis*, however, occurs at lower elevations and is not very common inside the forests.

Desmodium tiliæfolium —Like *Indigofera* this leguminous plant evidently helps to keep the soil fresh and rich through the activity of root bacteria. It does not, however occur to the same extent as *Indigofera* and grows down to almost 2,000′ altitude.

Rubus—(the commonest species being *R. niveus* and *R. biflorus*). These are very prominent in areas affected by fires and may form a dense covering on the ground when it would be found necessary to cut and burn them before any cultural works are undertaken. Poplar (*Populus ciliata*) also comes up in fire blanks and is useful as a nurse for the young seedlings against the midday sun.

Of the herbs enumerated above *Ainsliæa* and maiden-hair fern are good indicators but go well into fir areas and in damp situations, while *Fragaria*, though it disappears in damp localities, goes as high as 10,500′ on southern aspect and in open grass lands.

Violets love more or less shade and generally disappear in blanks.

Anaphalis is nearly always met with but where it assumes dominance the soil conditions are generally too dry.

Geranium nepalense at lower and *Geranium wallichianum* at higher elevations and *Galium* spp., are also generally associated with the deodar and represent favourable conditions.

Bracken is somewhat peculiar; for although it is often met with in favourable localities, yet wherever it assumes dominance, it is very difficult to obtain deodar regeneration.

In addition to the above *Onychium japonicum*, *Bœnninghausenia albiflora*, *Berberis* spp., *Cotoneaster bacillaris* and *C. acuminata* are generally associated with deodar forests, but they do not appear to be as constant as those enumerated above. *Oxalis* may also be met with especially under shade.

The list is not exhaustive but it is believed that a soil which contains most of the above species would certainly be suitable for the introduction of deodar where it is otherwise absent or for its natural regeneration when sufficient number of seed bearers are found in the area. As the factors of locality of the superficial layers of the soil go through many changes during the life of a forest, it is not uncommon to find that a deodar forest fails to regenerate itself even though the mother trees are fine and continue to grow vigorously. This may be due to the surface soil either becoming too wet or too dry for deodar seedlings and this would be reflected in the soil flora.

It is necessary however, to consider, so to say, the *toute ensemble* as the presence of an individual or two should not be taken as indicating a suitable soil. For example maiden-hair fern may appear in abundance in a locality somewhat too damp for deodar or one may still find an occasional *Ainsliaea* in an otherwise fir area. This latter brings us to the question of 'frequency' of the various indicators mentioned above, and it will be understood that just as one swallow does not make summer, similarly a few plants of *Ainsliaea* alone would not show that the soil conditions are right for deodar. It is obvious therefore that one must judge the soil factors of a locality by the luxuriance and degree of representation ('frequency') of the plant indicators than merely by the fact of their existence.

Another point of interest is the altitudinal 'range' of a species; for greater the range less the indicative value of that particular species and *vice versa*. For this reason also *Indigofera* certainly possesses a high value as its range of altitude is limited from 5,000′ to 8,500′. *Taraxacum officinale*, for example, on the other hand, with a range from 1,000′ to 18,000′ is useless as a soil indicator for any species.

It is surprising how one often comes across sudden changes in the soil flora with the change in soil conditions: be it due to a change in elevation aspect or configuration of the ground because of the intervention of a ravine or a damp nala or even to a change in the micro-climate of the soil. Moving, say, along a contour at 8,000′ on northern slope one would find that on the spurs the soil flora is typical of the one indicated above, but coming on to the nala, it suddenly changes to damp loving species and with that the change in the forest canopy from a kail (*Pinus excelsa*) or/and deodar forest to a fir is apparent. Elevation and northern aspect have the same effect so that with higher elevation the deodar forest again gives place to the firs. Here one finds such species as the following taking almost complete possession of the ground :—

Impatiens spp., *Strobilanthes* spp., *Staphylea emodi*, *Polygonums*, *Thalictrum*, *Senecio*, *Viburnum foetens*, *Polygonatum multiflorum*, *Trilium govanianum*, *Schizandra grandiflora* and *Arundinaria falcata* besides broad-leaved species which come in greater proportion. These

obviously indicate a cold and damp soil unsuitable for deodar. It must also be added that allowance has to be made for migration of the lower species higher up and for the higher ones coming lower down. Near the upper limit of deodar the natural ecological progression may have proceeded to a certain degree due to continuous forest cover which results in moister and more humid conditions so that the firs slowly invade into an otherwise deodar area. The soil flora here would generally be intermediate and would give the forester an indication of what he could do to get the deodar back. The obvious lesson for him would be so to manipulate the opening in the canopy as to bring about a retrocession—firs though economically of little importance as compared to deodar are however higher forms of life in nature—which he can do by a heavy opening which would dry out the soil, (grazing is another means of reducing the factors of locality). Such an opening will obviously bear heavily on the firs leaving the deodar as seed bearers. The effect of aspect will no doubt be kept in mind by the forester as it would be useless to attempt this retrocession on north and northeast aspects or in a nala where this succession is bound to pursue its course as ordained by nature. Species like *Plectranthus rugosus* and *Spiræa canescens* indicate that grazing is rather heavy and soil had dried out to such an extent that it would most probably be necessary to close the area before any cultural works are undertaken or natural regeneration of deodar will establish itself. *Caragana brevispina* also indicates dry conditions and the presence of *Spiræa sorbifolia* to any great extent, on the other hand, indicates adverse soil conditions where it is generally difficult to establish regeneration of deodar. Again it was observed that the following species predominate in 'thaches'—pastures—occurring within or outside the forests at elevations 7,500′ and above :—

Achillea millefolium, *Gentiana*, *Gypsophila*, *Cynoglossum*, *Plantago tibetica*, *Mazus* and *Pedicularis*. Obviously then any small patches within the forest which contain the above species are more suited as grass lands and it would be futile waste of money and energy in attempting to introduce deodar in such areas. Besides, it would be found advisable to leave such bits to serve as small grazing grounds for the village herds.

It would be interesting to hear of the observations of other Forest Officers on this subject, and it is hoped that some ecologist will throw more light on the subject in the pages of the *Indian Forester*.

EXPERIMENTS WITH FALKAMESAM PRESERVATIVE.

By A. V. Varadaraja Iyengar, M.Sc., A.I.C.

Department of Biochemistry, Indian Institute of Science, Bangalore.

The discovery of the Falkamesam Process marks an important stage in the development of wood preservatives. Apart from other considerations such as cost, etc., the advantage lies in the fixation of arsenic in the wood, from which the material cannot be easily removed. Moreover, the employment of simple leaching experiments to test such fixation is a technique, easy of test in the laboratory in place of the normal practice of testing through lapse of time and exposure to diverse weather conditions.

A detailed test of the process was undertaken at this Institute at the suggestion of Sir C. V. Raman. To this end, the method described by Popham and Kamesam (*Indian Forester*, 1932, **58**, 191) was closely followed. The wooden pieces (four at a time) were impregnated at 150 lbs. pressure for 5 hours in arsenic solution fixed according to the above process, in arsenic of the same concentration without the preservative, and in distilled water, the last two serving as controls for the first. The results of a typical experiment are given in the following table, representing the average of a number of determinations.—

TABLE I.

Relative weights of pieces (Acacia sp.) impregnated in the different solutions.

Impregnated fluid.	Arsenic with fixative.	Arsenic without fixative.	Water alone.
Weight in gms. before impregnation ..	71·75	71·75	71·05
Weight in gms. after impregnation ..	105·55	103·05	105·65
Weight in gms. after drying in steam oven for 36 hours	65·50	62·20	61·20
Loss (—) or gain (+) wt. as % on the initial wt.	—8·71	—13·31	—13·86

It is clear from the above that the loss in weight is least when the fixative is employed. Moreover, the pieces turn distinctly green after drying.

The amount of arsenic was estimated in the residual solution, after making up to a known volume and estimated as Magnesium Pyro-arsenate according to the method described in Treadwell (Analytical Chemistry: Quantitative 1919, p. 206).

The wooden pieces were separately analysed for arsenic after digestion with a mixture of nitric and sulphuric acids. The average values are presented in table II.

TABLE II.

Distribution of Arsenic in the impregnated pieces and in the residual solution.

(Expressed as gms. As_2O_5).

Wt. of arsenic in the original solution.	ARSENIC IN THE RESIDUAL SOLUTION.		ARSENIC IN THE WOOD.	
	Fixed.	Unfixed.	Fixed.	Unfixed.
3·572 ..	2·502	2·788	1·046	0·761

After drying, the pieces were subjected to leaching tests according to the authors mentioned above. The amount of arsenic leached out by shaking with water is shown in table III.

TABLE III.

Arsenic in the leached liquid.	In grams.	As % of the injected amt.
Fixed ..	0·0470	5·62
Unfixed ..	0·4650	38·45

The above data conclusively show that treatment of wood with Falkamesam fixative serves better to fix arsenic and does not leach it out to any appreciable extent on shaking with water. It would be of interest to determine the mechanism of arsenic fixation in the above process.

The author expresses his thanks to Sir C. V. Raman, Kt., F.R.S., N.L., for permission to carry out the tests.

1-6-32 1-6-32 15-5-32 1-5-32 15-4-32 15-4-32 1-5-32 15-5-32 1-6-32

Premonsoon Stump-planting of Teak. Effect of planting at fortnightly intervals from 15-4-32 to 15-6-32.

Dhoni Experimental Garden,
Palghat Division, Madras.

Photo : S. G. Venkataramanan,
Forest Research Ranger,
17th September, 1932.

EARLY STUMP PLANTING OF TEAK.

BY M. V. LAURIE, I.F.S., SILVICULTURIST, MADRAS.

There are one or two points in the article on the "Early stump planting of Teak" by H. Sen Gupta in the March number of the *Indian Forester* that cannot be allowed to pass unchallenged.

Repeated experiments, of which the data are given below, have shown that early stump planting of teak in April or even March is successful even though the planting be done in dry weather and followed by a considerable number of rainless days. It is almost certainly incorrect to say that the failure in the stump planted area in Walayar (Madras Forest College area of 1931), which was planted in June, was due to the rainless period of twelve days that followed planting, though I am unable to state what this comparative failure is due to unless it be inexperienced planting and failure to get the soil tight round the tips of the stumps. It is also incorrect to say that "it is mainly in order to avoid the risk of getting a break in the rains at the critical time just after planting out that the stump planting of teak in Nilambur, Walayar, Travancore and other places in South India is done when the monsoon has set in regularly." Such a statement would certainly be applicable to entire transplants which are very susceptible to unfavourable weather shortly after planting, but in the case of stumps the reverse is the case. The data given below conclusively prove the great advantage in height growth combined with a good percentage of survivals, of early stump planting in our moister areas affected by the south-west monscon, and also demonstrate the hardiness of teak stumps to periods of drought following planting. The rainfall in April in all the localities where the experiment was done, varied from 0·8″ to 1·5″ maximum, and the number of rainy days in the month varied from four to ten, but is usually less than six. A photograph (Plate 57) illustrating one of these experiments is attached. The experiments have now been repeated five times in different localities and the results are given in the following table.

Locality and Year.	Dates of planting.	Number of stumps planted.	Results by following March. Percentage of survivals.	Mean height in inches with Standard Error.	Difference of means from control (June 1st).	Remarks.
Anaipady, South Coimbatore Divisions, 1932.	15th April	70	99(a)	354·8±1·88	+14·1″	Significant.
	1st May..	70	100	33·5±1·55	+11·8″	,,
	15th May..	70	99	32·7±1·53	+11·0″	,,
	1st June..	70	91	21·7±1·12	Control	..
	15th June..	70	89	17·0±0·86	—4·7″	Significant.
Dhoni, Walayar Division. 1932.	15th April..	100	100	38·5±2·24	+24·7″	Significant
	1st May ..	100	71	30·2±2·26	+16·4″	,,
	15th May ..	100	100	26·8±1·30	+13·0″	,,
	1st June ..	100	95	13·8±0·73	Control	..
	15th June ..	100	92	13·3±0·82	—0·05	Not significant.
Begur, Wynaad Division. 1932.	18th April..	200	100	55·75±1·32	+25·93″	Significant.
	2nd May..	200	100	48·11±0·94	+18·29″	,,
	16th May ..	200	99	49·40±0·98	+19·58″	,,
	2nd June..	200	91	29·82±0·80	Control	..
	15th June..	200	87	20·56±0·63	—9·26″	Significant.
Topslip, South Coimbatore Division, 1933.	16th March	100	87 (b)	58·1±1·99	+37·0	Significant.
	1st April ..	100	99	57·7±2·05	+36·6	,,
	16th April	100	86	45·6±2·20	+24·5	,,
	1st May ..	100	95	28·8±1·32	+7·7	..
	16th May ..	100	90	21·6±0·96	+0·5	Not significant.
	1st June ..	100	82	21·1±1·01	Control	..
Begur, Wynaad Division, 1933.	18th March	100	66	22·2±1·68	+11·6	Significant.
	1st April ..	100	91	24·0±1·91	+13·4	,,
	15th April..	100	76	17·5±1·10	+6·9	,,
	1st May ..	100	91	19·0±1·00	+8·4	,,
	15th May ..	100	93	15·4±0·83	+4·8	,,
	2nd June..	100	79	10·6±0·54	Control	..
Dhoni, Palghat Division, 1933.	16th March..	100	80	49·0±2·59	21	Significant.
	1st April ..	100	79	59·0±2·59	31	,,
	16th April ..	100	94	48·0±2·05	20	,,
	1st May ..	100	82	38·0±2·06	10	,,
	16th May ..	100	98	35·0±1·55	7	,,
	1st June ..	100	92	28·0±1·30	Control	..

(a) Planting followed by 4 dry days, 2 days on which 0·1 inches fell, and then another 16 dry days, yet 99 per cent. survived.

(b) Planting followed by 25 dry days, 87 per cent. survived.

On the results of the above experiments early stump planting is now being adopted as the regular procedure in several of the teak tracts affected by the south-west monsoon where the rainfall is over about 60 inches. The actual date of planting is usually decided in practice by the first showers since moist soil facilitates planting, but it should be as early in April as possible. Hitherto stump planting has not been popular at Nilambur, because, on the few occasions on which it was tried, (at the commencement of the rains), considerable casualties occurred on account of the stumps rotting in the ground. There appears to be little doubt that excessive moisture was the cause of trouble and that early stump planting is the remedy. It still remains to be proved to what extent such early planting can be done in the drier tracts and experiments to test this are being initiated.

Mr. Sen Gupta's remarks on the thickness of stumps require some qualification. The experimental evidence is strong that *under normal pre-monsoon conditions* large stumps up to 0·8″ in diameter give better growth than small stumps, and that the percentage of survivals in stumps that are thicker than a pencil is fairly constant, there being no marked falling off in the larger sizes. There is, however, a certain prejudice against the use of large stumps, and it is noticeable that the places from which the experiences of failure with large stumps are reported are localities with high rainfall. (Nilambur —120″, Travancore—170″, and North Mangalore—over 200″). It is possible that large stumps may be more susceptible to rot in waterlogged or very wet soils than small stumps. (By "large stumps" I mean stumps of 0.6″ to 1.0″ diameter at the thickest part, and "small stumps" 0.4″ to 0.6″ diameter. Stumps smaller than 0.3″ have proved definitely inferior).

I very much doubt whether Mr. Sen Gupta's ingenious explanation of the suggested inferiority of large stumps is borne out by experience. He suggests the large stump sprouts and lives on its food stores ultimately exhausting them without developing a root system proportional to the size of the shoots. It is a matter that could easily be settled by direct observation, but, as already stated,

the evidence indicates that, provided the conditions are not too wet, large stumps give as good a percentage of survivals and better height growth than small stumps. Further experiments are, however, in progress to determine the best size of teak stumps to use under varying conditions.

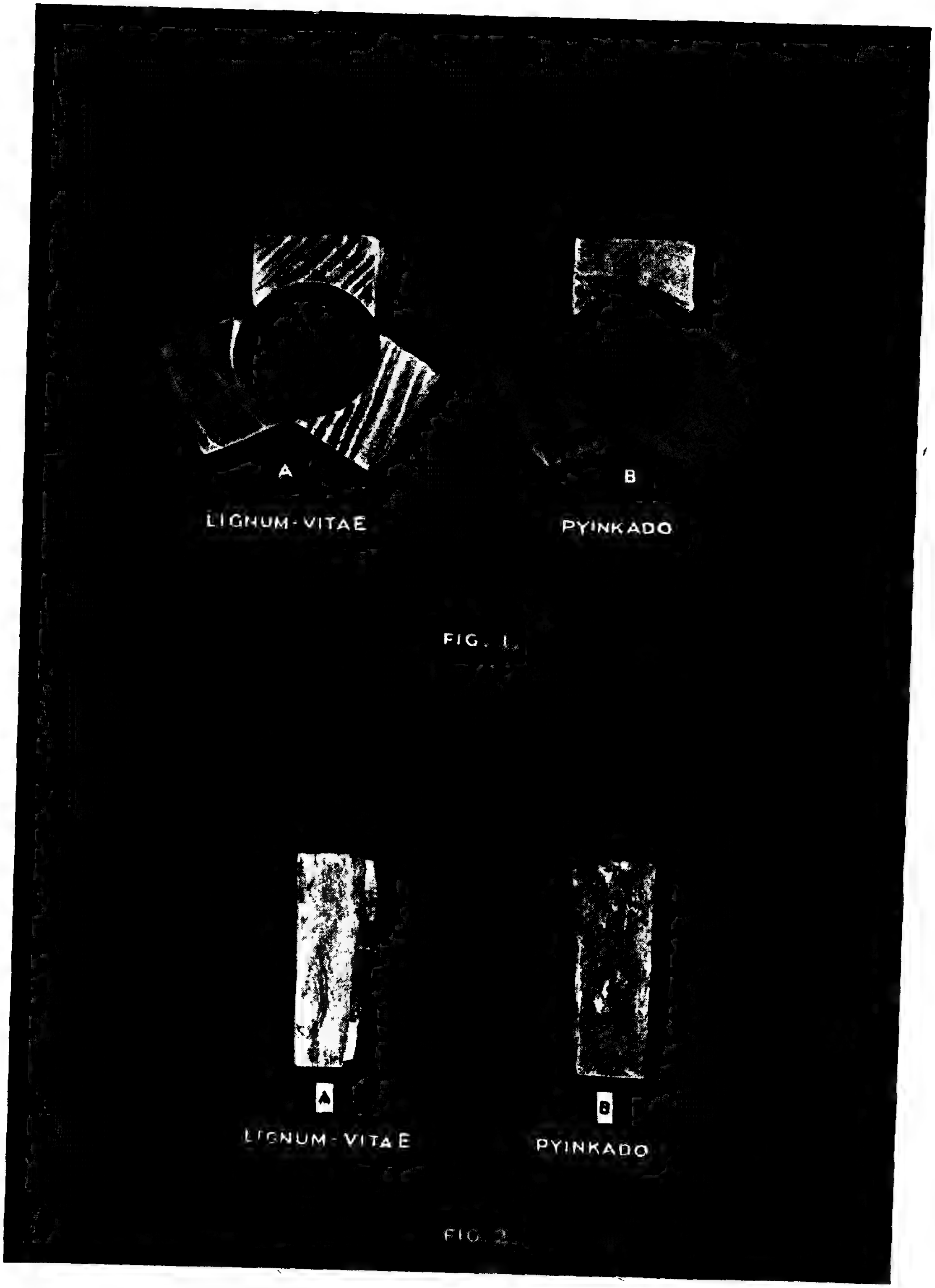
WOODEN BEARINGS.

By L. N. Seaman, Officer-in-charge, Timber Testing Section, F.R.I.

For many years the standard material for wooden bearings, such as the stern tube liners on steamships and turbine bearings, has been Lignumvitæ. (*Guaiacum officinale*, Linn.), and allied species from the West Indies. Suitable supplies for the best bearings are expensive, and frequent attempts have been made to find suitable substitutes. Some years ago Burma blackwood, (*Dalbergia cultrata*, Grah.), was fitted on some tug boats in Burma, and after a fair trial was reported to be satisfactory. More recently the writer suggested that pyinkado, (*Xylia dolabriformis*, Benth.), should be expected to make satisfactory bearings. A trial was made on an installation of moderately large turbines on which Lignumvitæ had formerly been used. No actual data were obtained from this trial, but the users reported that " the pyinkado was nearly as good as the Lignumvitæ ". Considering that the cost of the former is but a fraction of that of the latter, this, in itself, meant that very considerable economies were possible.

The matter, however, did not end there. In 1932 the opportunity arose to make another trial of pyinkado bearings on a turbine and this time under conditions which admitted of observation and the collection of actual data. The results show pyinkado bearings to be much better than was expected, for in this trial they lasted much longer than the Lignumvitæ. The trial was made as follows :—

A new set of Lignum-vitæ blocks was installed and run till it was worn out. The total number of working hours was recorded, and



Wooden Bearings.

T 10577.
T 10578.

Photo : Har Swarup.
January 1934.

a separate record kept for July, August and September, those being the months when, on account of extra silt in the water, the wear is probably heaviest. This set was then replaced by a new set consisting of two pyinkado blocks and one Lignumvitæ block, and the working hours recorded as before. This set was removed when the Lignumvitæ block was worn beyond use. The pyinkado blocks were also taken out for comparison, but were very little worn and fit for much longer service. The trial was made on a 10—20 B. H. P. turbine which delivered, on an average, 15 H. P. The shaft was of 2″ diam. with a speed of about 300 r. p. m. The following is the record of the work done by each set of bearings :—

Lignumvitæ.

Period.		Working hours.
May and June, 1932	..	234 hours.
July to September, 1932	..	229 ,,
October, 1932	..	112 ,,
Total	..	575 ,,

These blocks were removed, completely worn out, on the 17th October 1932, and replaced by the set containing two pyinkado blocks.

Pyinkado.

Period.		Working hours.
October 1932 to June 1933	..	2,754 hours.
July to September 1933	..	291 ,,
October to December 1933	..	828 ,,
Total	..	3,873 ,,

These blocks were removed on the 19th of December, 1933, because the Lignumvitæ one was worn far beyond its useful life and *must* come out. The pyinkado blocks were little worn and good for considerably more service. It should be noted, not only that this set had been in use for nearly seven times as many working hours as the all Lignumvitæ set, but also that it had been used in the heavily silted water of July, August and September for an extra 62 hours.

The conditions of the two sets of bearings, while not nearly so evident in a photograph as when the blocks themselves can be examined, are seen in Fig. 1, plate 58. The two pyinkado blocks, (the lower, dark blocks in B. Fig. 1), are less worn than the Lignum-

vitæ blocks (A. Fig. 1), although they have been used for nearly seven times as long.

Figure 2 illustrates the fact that, besides wearing longer, the pyinkado blocks wore much more evenly than Lignumvitæ. Note how the latter. (A. Fig. 2) is not only much worn, but is also worn away more at one end than at the other, while the edges of the pyinkado block have remained almost parallel.

This trial was made on a rather small turbine. The bearings, however, were used under ordinary service conditions, and there is no reason to suppose that their behaviour is not a reasonable indication of what may be expected of pyinkado as wood for bearings of shafts which run in water.

BRANCHING OF TEAK.

By D. S. Kaikini, Range Forest Officer, Karwar, Bombay.

The note by Mr. V. R. Kamalapur, Range Forest Officer, published in the January issue of the *Indian Forester*, regarding the incidence of branching of teak in plantations prompts me to give in the next few lines a few suggestions as a result of my observations on the subject.

Mr. Kamalapur states that the branching is due to trampling of the plants by cattle. That is but an ordinary and natural incident. I have found however that branching is noticeable even in plantations where cattle hardly ever go. One of the apparent causes is observed to be the very poor soil on which plantations are raised. It is generally the experience of many that the quality of the soil varies in different parts even of the same coupe, and a clear felled coupe does not always contains soil uniformly suitable for a plantation throughout its length and breadth. An area containing grass and poor shrubbery in the coupe will not contain good soil for plantation even after clear felling and burning. And plants raised in such an area are invariably branchy and stunted. Poverty of soil is, therefore, one of the main causes of branching in teak.

I have also observed such branching higher up towards the crown in the case of some vigorously grown plants also. Within a

year or two of raising a plantation in a clear felled and burnt coupe, one is sure to come across the invasion of long-spreading evergreen creepers. These creepers are seen encircling the leading shoot, like the loosely woven turban of a South Indian durwan and smothering the very life of the plants. The plants thus strangled by creepers are mostly found throwing out two other leaders on two opposite sides as a special adaptation for the plant to carry on its physiological functions. When the leader is smothered, dormant buds higher up in the region appear to shoot out and undertake to carry on the usual functions. This is another cause of branching of teak noticed by me in the plantations. To prevent this, it is obvious that cultural operations involving creeper-cutting have to be carried on carefully as often as necessary.

Yet another cause may be found in the origin of the seed. Teak seed is often collected for convenience from the forests where teak generally matures when of pole size. The parent trees are generally branchy. The characteristics of the parent tree are said to be inherited by the seed and are in turn exhibited in the resulting plant. I have seen in my Range a teak plantation, now five years old, containing plants fairly vigorous but branchy for none of the causes enumerated above, and on enquiry about the seed used, I understood it was from the pole size teak forest. In Gund which is the home for teak the young plantations contain branchy plants, I am told, and it is learnt that the seed used is from the pole forest.

INDIAN FOREST STATISTICS.

The following tables have been prepared for submission to the Empire Forestry Association for incorporation in its statistics and as they contain much that should be of interest to our readers, we reproduce them below. The figures for the number of factory labourers directly dependent upon forests for their employment in Table V are given for the first time, though it is felt that it gives a very inadequate figure for persons dependent on forestry for their livelihood as it gives no indication of the millions of villagers who are indirectly dependent upon forest produce or are part time employed on casual forest work in government and other forests. [*Editor.*]

TABLE I.

Area (In Square Miles).

Province.	Kind of Timber.	Forest. Merchantable.	Forest. Unprofitable or not Accessible.	Forest. Total.	Agricultural Land.	Other Land.	Total Land.	Total Forest Area as percentage of Total Land Area.
MADRAS ..	Broad-leaved	16,519	22,315	38,834	74,026	30,430	143,290	27·1
BOMBAY ..	Broad-leaved	9,405	5,463	14,868	84,005	26,547	125,420	11·85
BENGAL ..	Conifers ..	..	21	21	..	..	..	..
	Broad-leaved	8,753	3,518	12,271	41,805	18,788	75,885	16·18
UNITED PROVINCES.	Conifers ..	925	1,272	2,197	..	..	..	..
	Broad-leaved	4,487	10,698	15,185	55,535	33,323	106,240	16·3
PUNJAB ..	Conifers ..	926	1,161	2,087	..	..	..	..
	Broad-leaved	360	3,651	4,011	47,929	37,156	91,183	6·7
BURMA ..	Broad-leaved	80,109	66,097	146,206	33,801	63,508	243,515	60·0
BIHAR AND ORISSA.	Broad-leaved	8,783	28,197	36,980	53,634	21,086	111,700	30·0
CENTRAL PROVINCES.	Broad-leaved	34,810	11,743	46,553	50,312	6,909	103,774	44·9
ASSAM ..	Conifers ..	33	..	33	..	..	..	..
	Broad-leaved	3,618	18,515	22,133	14,812	21,736	58,714	37·7
COORG ..	Broad-leaved	762	408	1,170	373	39	1,582	74·0
AJMER ..	Broad-leaved	100	42	142	933	1,692	2,767	5·2
NORTH-WEST FRONTIER PROVINCE.	Conifers ..	143	31	174	..	..	..	..
	Broad-leaved	384	418	802	4,333	8,077	13,386	7·29
BALUCHISTAN	Conifers ..	..	310	310	..	..	..	..
	Broad-leaved	..	478	478	577	45,595	46,960	1·70
ANDAMANS ..	Broad-leaved	1,850	608	2,458	50	..	2,508	98·0
Total ..	Conifers ..	2,027	2,795	4,822	..	..	..	..
	Broad-leaved	169,940	172,151	342,091	465,125	314,886	1,126,924	..
Grand Total ..	..	171,967	174,946	346,913	465,125	314,886	1,126,924	..
Percentage of Total Land Area.		15·2	15·5	30·7	41·2	27·9	..	..

TABLE II.

Volume of Standing Timber.

Province.	Kind of Timber.	Merchantable.		Unprofitable or Inaccessible.		Total million.
		Per square mile.	Total million.	Per square mile.	Total million.	
		c. ft.	c. ft.	c. ft.	c. ft.	c. ft.
Madras ..	Broad-leaved ..	84,620	1,141	107,558	1,332	2,473
Bombay ..	Broad-leaved ..	231,750	2,180	87,993	480	2,660
Bengal ..	Broad-leaved ..	767,357	1,942	12,800	23	1,965
	Conifers ..	..	..	641,803	13	13
United Provinces ..	Broad-leaved ..	352,000	1,579	7,000	75	1,654
	Conifers ..	332,800	239	120,000	153	392
Punjab ..	Broad-leaved ..	219,000	79	35,000	127	206
	Conifers ..	906,000	839	463,000	537	1,376
Burma ..	Broad-leaved ..	500,000	23,629	250,000	16,524	40,153
	Broad-leaved but workable for teak only ..	50,000	1,643	450,000	14,782	16,425
Bihar and Orissa ..	Broad-leaved ..	590,000	5,160	230,000	6,362	11,522
Central Provinces	Broad-leaved ..	75,000	2,611	25,000	294	2,905
Assam ..	Broad-leaved ..	128,000	464	6,400	117	581
Coorg ..	Broad-leaved ..	166,659	127	44,000	18	145
Ajmer ..	Broad-leaved ..	..	..	..	..	..
North-West Frontier Province.	Broad-leaved ..	722,000	13	132,000	7	20
	Conifers ..	853,000	122	64,500	2	124
Baluchistan ..	Conifers ..	..	..	..	..	..
Andamans ..	Broad-leaved ..	960,000	1,782	480,000	163	1,945
Total ..	Conifers ..	2,091,800	1,200	1,289,303	705	1,905
	Broad-leaved ..	4,846,386	42,350	867,751	40,304	82,654
Grand Total ..	..	6,938,186	43,550	2,157,054	41,009	84,559

TABLE III.

ANNUAL INCREMENT.

(On Merchantable Areas Dedicated to Timber Production).

Province.	Ownership.	Area, square miles.	CONIFERS. Estimated gross increment. Per sq. mile.	CONIFERS. Estimated gross increment. Total million.	CONIFERS. Loss by fire, waste and decay.	CONIFERS. Net increment (col. 3—col. 4).	Area, Square miles.	BROAD-LEAVED. Estimated gross increment. Per square mile.	BROAD-LEAVED. Estimated gross increment. Total million.	BROAD-LEAVED. Loss by fire, waste and decay.	BROAD-LEAVED. Net increment (col. 8—col. 9).	Total net increment (col. 5+col. 10).
		1	2	3	4	5	6	7	8	9	10	11
			c.ft.	M.c. ft.	M.c ft.	M.c. ft.		c.ft.	M.c. ft.	M.c. ft.	M.c ft	M.c. ft
MADRAS ..	State	..	..	..	..	..	4,151	6,800	28	8	20	20
	Other	..	..	..	..	..	5,482	3,400	19	13	6	6
BOMBAY ..	State	..	..	..	..	..	8,303	940	8	1	7	7
	Other	..	..	..	..	..	..	..	..	..	..	..
BENGAL ..	State	..	..	..	..	..	7,203	8,930	13	..	13	13
	Other	..	..	..	..	..	1,550	2,462	1	..	1	1
UNITED PROVINCES.	State	918	14,320	7	..	7	2,573	12,040	18	..	18	25
	Other	7	7,000	..	..	..	1,200	5,000	6	..	6	6
PUNJAB ..	State	794	14,000	11	3	8	360	12,000	4	1	3	11
	Other	132	6,400	1	..	1	..	..	..	..	..	1
BURMA ..	State	..	..	..	..	..	24,127	12,500	301	217	84	84
	Other	..	..	..	..	..	..	..	..	..	..	..
BIHAR & ORISSA	State	..	..	..	..	..	902	7,680	7	..	7	7
	Other	..	..	..	..	..	6,289	9,600	60	20	40	40
CENTRAL PROVINCES.	State	..	..	..	..	..	12,577	3,500	44	8	36	36
	Other	..	..	..	..	..	18,905	2,000	38	15	23	23
ASSAM ..	State	6	..	..	..	..	3,276	640	2	..	2	2
	Other	27	..	..	..	..	342	..	..	..	..	..
COORG ..	State	..	..	..	..	..	563	1,936	1	1	..	..
	Other	..	..	..	..	..	199	845	..	..	..	..
N.-W.F. PROVINCE	State	159	152,954	3	..	3	207	62,301	1	..	1	4
	Other	366	..	..	..	..	..	..	..	..	..	..
BALUCHISTAN ..	State	..	..	..	..	..	..	..	..	..	..	..
AJMER ..	State	..	..	..	..	..	..	..	..	..	..	..
ANDAMANS ..	State	..	..	..	..	..	142	3,000	..	..	..	..
	Other	..	..	..	..	..	1,850	11,520	21	18	3	3
TOTAL FOR INDIA	State	1,877	181,274	21	3	18	66,234	143,787	418	254	194	212
	OTHER	532	13,400	1	..	1	33,967	23,307	124	48	76	77
GRAND TOTAL	..	2,409	194,674	22	3	19	100,201	167,094	572	302	270	289

TABLE IV.

Forest Area by ownership (in square miles).

Province.	Type of Forests.	The State. Dedicated to timber production.	Other Forest.	Total.	Corporate Bodies.	Private individuals.	Total.
1	2	3	4	5	6	7	8
Bengal ..	Merchantable ..	7,078	31	7,109	..	1,654	8,763
	Unprofitable or inaccessible ..	21	3,445	3,466	..	..	3,466
United Provinces.	Merchantable ..	3,491	700	4,191	21	1,200	5,412
	Unprofitable or inaccessible ..	..	10,084	10,084	..	1,876	*11,960
Punjab ..	Merchantable ..	860	231	1,091	132	..	1,223
	Unprofitable or inaccessible ..	1,158	3,029	4,187	666	..	4,853
Burma ..	Merchantable (all species) ..	10,392	34,113	44,505	..	..	44,505
	Merchantable (Teak only) ..	11,324	16,085	27,409	..	..	27,409
	Unprofitable or inaccessible ..	6,736	42,905	49,641	..	..	49,641
Federated Shan States	Merchantable (all species) ..	434	2,319	2,753	..	..	2,753
	Merchantable (Teak only) ..	1,977	3,465	5,442	..	..	5,442
	Unprofitable or inaccessible ..	716	15,740	16,456	..	..	16,456
Bihar & Orissa	Merchantable ..	902	2,113	3,015	..	19,675	22,690
	Unprofitable or inaccessible ..	..	679	679	..	13,611	†14,290
Assam ..	Merchantable ..	3,282	..	3,282	52	317	3,651
	Unprofitable or inaccessible ..	2,869	15,646	18,515	..	..	18,515
Central Provinces.	Merchantable ..	12,221	‡8,179	20,400	..	25,479	45,879
	Unprofitable or inaccessible ..	..	‡2,698	2,698	..	21,889	24,587
Coorg ..	Merchantable ..	372	191	563	..	199	762
	Unprofitable or inaccessible ..	123	139	262	..	146	408
North-West Frontier Province.	Merchantable ..	161	3	164	..	..	164
	Unprofitable or inaccessible ..	18	67	85	.	595	680
Ajmer ..	Merchantable ..	..	142	142	..	..	142
	Unprofitable or inaccessible ..	..	..	..	..	..	..
Baluchistan	Merchantable ..	..	..	..	..	..	..
	Unprofitable or inaccessible ..	..	788	788	..	..	788
Andamans ..	Merchantable ..	2,190	..	2,190	..	..	2,190
	Unprofitable or inaccessible ..	..	..	..	..	..	..
Madras ..	Merchantable ..	3,361	8,057	11,418	..	7	11,425
	Unprofitable or inaccessible ..	..	8,099	8,099	..	1,325	9,424
Bombay ..	Merchantable ..	7,446	2,115	9,561	..	222	9,783
	Unprofitable or inaccessible ..	..	5,307	5,307	..	..	5,307
Total ..	Merchantable ..	65,491	77,744	143,235	205	48,753	192,193
	Unprofitable or inaccessible ..	11,641	108,626	120,267	666	39,442	160,375
	Grand Total ..	77,132	186,370	263,502	871	88,195	352,568
	Percentage of total Forest Area	21·9	52·9	74·8	0·2	25·0	100·0

* Area of forests under Native States (2,300 square miles) has been omitted.
† 6,289 square miles represent forest area of Orissa States.
‡ Includes 2,482 and 1,172 square miles of Ryotwari Forests respectively.

TABLE V.

Primary Forest Industries.

Industry.	Quantity of timber and minor forest produce consumed (home-grown only).	Value of product at the place of preparation.	Number of Persons employed under— (a) Primary Forest Production.	(b) Factory Hands.
MADRAS.		Rs.		
1. Felling and logging, etc. 2. Sawing 3. Sawmills and timber loads 4. Carpentry ..	Timber 3,390,000 c.ft. Fuel 18,390,000 c.ft.	Timber 9,04,827 Fuel 7,28,520	2,142,304	390,832
5. Baskets, etc.	34,000,000 (bamboos)	5,57,267	1,920,977	539,871
6. Resin ..	½ ton	27	10	..
7. Cutch ..	16,080 tons	10,960	11,275	..
8. Lac ..	52·3 tons	880	1,816	..
9. Matches ..	31,357 c.ft.	14,147	..	86,700
11. Fodder ..	2,000,000 cattle	6,30,560	..	..
12. Sandal ..	20,000	6,72,800	2,000	7,070
Total ..	..	35,19,988	4,078,382	1,024,473
BOMBAY.				
1. Felling and logging, etc. 2. Sawing .. 3. Sawmills and timber loads 4. Carpentry ..	Timber 6,000,000 c.ft.	Timber 45,29,400	44,500	40,000
	Fuel 46,000,000 c.ft.	Fuel 9,24,213	61,000	..
5. Baskets, etc.	..	1,98,293	10,000	..
7. Cutch ..	..	..	100	..
8. Lac ..	..	..	100	..
9. Matches ..	..	..	..	500
11. Fodder ..	..	15,06,507	10,000	..
12. Sandal .	..	1,47,973	1,000	100
Total ..	..	73,06,386	126,700	40,600
BENGAL.				
1. Felling and logging, etc. 2. Sawing 3. Sawmills and timber loads 4. Carpentry	Timber 16,500,000 c.ft. Fuel 14,200,000 c.ft.	Timber 34,19,360 Fuel 2,73,533	240,000	40,000
5. Baskets, etc. ..	30,900,000 (bamboos)	1,58,640	140,000	..
7. Cutch ..	..	..	500	..
9. Matches ..	..	..	50	..
10. Paper ..	..	..	3,000	2,000
11. Fodder ..	40,000 cattle	70,507	..	..
Total ..	..	39,22,040	383,550	42,000

TABLE V.—(*contd.*)

Primary Forest Industries.

Industry.	Quantity of timber and minor forest produce consumed (home-grown only).	Value of product at the place of preparation.	Number of Persons employed under— (a) Primary Forest Production.	(b) Factory Hands.
United Provinces.		Rs.		
1. Felling and logging, etc. 2. Sawing 3. Sawmills and timber loads 4. Carpentry	Timber 8,211,835 c.ft. Fuel 23,219,000 c.ft.	Timber 29,65,693 Fuel 2,18,387	57,000	178,000
5. Baskets, etc.	16,881,000 (bamboos)	96,747	5,600	47,800
6. Resin ..	2,347 tons	1,57,000	1,500	300
7. Cutch ..	14,500 tons	4,93,333	2,500	150
8. Lac ..	..	..	354	..
9. Matches ..	103,000 c.ft.	50, 667	..	400
10. Paper ..	12,500 tons (grass baib)	1,21,333	1,750	..
11. Fodder ..	1,010,237 cattle	4,52,453	..	..
Total ..	..	45,55,613	68,704	226,650
Punjab.				
1. Felling and logging, etc. 2. Sawing .. 3. Sawmills and timber loads 4. Carpentry ..	Timber 4,550,000 c.ft.	Timber 4,00,000	2,089	8,000
	Fuel 28,000,000 c.ft.	Fuel 8,66,667	141,986	..
5. Baskets, etc.	580,000(bamboos)	17,333	25,567	..
6. Resin ..	2,200 tons	30,667	1,200	250
9. Matches ..	..	..	..	300
10. Paper ..	..	..	..	300
11. Fodder ..	3,300,000 cattle	13,33,333	..	..
Total ..		26,48,000	170,842	8,850
Burma.				
1. Felling and logging, etc 2. Sawing .. 3. Sawmills and timber loads 4. Carpentry ..	Timber 43,730,000 c. ft.	Timber 2,99,64,693	109,555	15,000
	Fuel 54,390,000 c.ft.	Fuel 5,39,373	16,409	..
5. Baskets etc. ..	89,950,000 (bamboos)	2,91,720	81,983	..
7. Cutch ..	4,435 tons	1,47,173	4,435	..
8. Lac ..	3,628 tons	4,29,267	550	..
9. Matches ..	..	..	..	1,374
11. Fodder ..	510,000 cattle	2,26,587	1,137	..
Total ..	..	3,15,98,813	214,069	16,374

TABLE V.—(*contd.*)
Primary Forest Industries.

Industry.	Quantity of timber and minor forest produce consumed (home-grown only).	Value of product at the place of preparation.	Number of Persons employed under— (a) Primary Forest Production.	(b) Factory. Hands.
Bihar and Orissa.		Rs.		
1. Felling and logging etc. / 2. Sawing .. / 3. Sawmills and timber loads / 4. Carpentry ..	Timber 2,600,000 c.ft.	Timber 12,51,280	3,000	2,000
	Fuel 7,500,000 c.ft.	Fuel 1,08,813	10,000	..
5. Baskets, etc.	7,016,000 (bamboos)	56,880	5,000	1,000
7. Cutch ..	..	..	5,000	1,000
8. Lac ..	27 tons	11,680	17,500	2,500
10. Paper ..	3,060 tons	24,000	2,000	5,000
11. Fodder ..	500,000 cattle	1,30,000	..	..
Total ..	..	15,82,653	60,500	11,500
Central Provinces.				
1. Felling and logging, etc. / 2. Sawing .. / 3. Sawmills and timber loads / 4. Carpentry ..	Timber 8,400,000 c.ft.	Timber 17,41,267	999,000	1,000
	Fuel 21,000,000 c.ft.	Fuel 4,85,427		
5. Baskets, etc.	20,000,000 (bamboos)	3,12,813	50,000	..
7. Cutch ..	30 tons	20,000	1,000	..
8. Lac ..	70 tons	15,973	9,750	250
11. Fodder ..	3,300,000 cattle	18,50,133	30,000	..
Total ..	..	44,25,613	1,089,750	1,250
Assam.				
1. Felling and logging, etc. / 2. Sawing .. / 3. Sawmills and timber loads / 4. Carpentry ..	Timber 9,000,000 c.ft.	Timber 16,27,640	20,000	4,000
	Fuel 8,000,000 c.ft.	Fuel 82,093		
5. Baskets, etc.	16,543,902 (bamboos)	23,947	14,000	..
8. Lac ..	1,764 tons.	1,89,333	..	..
Total ..	..	19,23,013	34,000	4,000
Coorg.				
1. Felling and logging, etc. / 2. Sawing .. / 3. Sawmills and timber loads / 4. Carpentry ..	Timber 190,000 c.ft.	Timber 1,08,893	8,300	..
	Fuel 160,000 c.ft.	Fuel 6,733	3,600	..
5. Baskets, etc.	690,347 (bamboos)	2,667	626	..
11. Sandal ..	90,000 c.ft.	2,81,947	7,110	..
Total ..	..	4,00,240	19,636	.

TABLE V.—(*concld*).

Primary Forest Industries.

Industry.	Quantity of timber and minor forest produce consumed (home-grown only).	Value of product at the place of preparation.	Number of Persons employed under— (a) Primary Forest Production.	Number of Persons employed under— (b) Factory Hands.
Ajmer.		Rs.		
1. Felling and logging, etc. 2. Sawing .. 3. Sawmills and timber loads 4. Carpentry ..	Timber 4,348 c.ft. Fuel 446,499 c.ft.	Timber 666 Fuel 31,587	1,000	..
11. Fodder ..	..	..	2,500	
Total ..	..	32,253	3,500	..
N.-W. F Province.				
1. Felling and logging, etc. 2. Sawing .. 3. Sawmills and timber loads 4. Carpentry ..	Timber 1,763,518 c.ft. Fuel 2,527,500 c.ft.	Timber 1,69,267 Fuel 1,00,973	10,491	2,117
5. Baskets, etc.	..	..	..	202
6. Resin ..	448 tons	17,920	217	..
11. Fodder ..	12,644 cattle	5,773	..	..
Total ..	..	2,93,933	10,708	2,319
Baluchistan.				
1. Felling and logging, etc. 2. Sawing .. 3. Sawmills and timber loads 4. Carpentry ..	Timber 4,932 c.ft.	Timber 1,333	16	..
	Fuel 381,495 c.ft.	Fuel 18,387	1,276	..
11. Fodder ..	60,000 cattle	8,00,000	3,900	..
Total ..	..	8,19,720	5,192	..
Andamans.				
1. Felling and logging, etc. 2. Sawing .. 3. Sawmills and timber loads 4. Carpentry ..	Timber 2,144,722 c.ft.	Timber 4,96,787	360	..
	Fuel 1,023,441 c.ft.	Fuel 36,840	..	541
5. Baskets, etc.	709,829 (bamboos)	1,960	..	..
9. Matches ..	..	..	197	..
Total ..	..	5,35,587	557	541
India.				
1. Felling and logging, etc. 2. Sawing .. 3. Sawmills and timber loads 4. Carpentry	Timber 106,[illegible]89,355 c.ft Fuel 225,237,935 c.ft.	Timber 4,75,81,107 Fuel 44,21,547	3,871,886	681,490
5. Baskets, etc.	217,271,078 (bamboos)	17,18,267	2,253,753	588,873
6. Resin ..	5,006 tons	2,05,613	2,927	550
7. Cutch ..	35,045 tons	6,71,467	24,810	1,150
8. Lac ..	5,541 tons	6,47,133	30,070	2,750
9. Matches ..	134,357 c.ft.	64,813	247	89,274
10. Paper ..	15,560 tons.	1,45,333	24,750	7,300
11. Fodder ..	10,732,881 cattle	70,05,853	47,537	..
12. Sandal ..	110,000 c.ft.	11,02,720	10,110	7,170
	Grand Total ..	6,35,63,853	6,266,090	1,378,557

TABLE VI.

The figures are taken directly from the Annual Statements of the Sea-Borne Trade of British India with the British Empire and Foreign Countries, *Average Annual Exports and Imports of Timbers and Minor Forest Products of India.*

1. TIMBER, WOOD MANUFACTURES.

Type of produce.	Exports. Value. Rs.	Exports. Quantity. Converted Million c ft.	Exports. Quantity. Equivalent in standing timber. Million c.ft.	Imports. Value. Rs.	Imports. Quantity. Converted. Million c.ft.	Imports. Quantity. Equivalent in standing timber. Million c.ft.
1	2	3	4	5	6	7
Conifers ..	..	..	..	9,96,280	·001	·002
Total ..	..	..	..	9,96,28	·001	·002
Broad-leaved.						
Teak ..	12,507,253	2·265	4·530	15,29,160	·052	·104
Teak Keys ..	4,30,373	0·012	0·024	..	..	..
Jarrah ..	..	..	..	9,72,280	·041	·082
Sandal ..	14,90,440	0·004	0·008	2,10,640	·002	·004
Firewood ..	17,987	0·004	0·008	11,000	·004	·008
Other kinds ..	5,24,440	0·044	0·088	34,41,840	2·900	5·800
Manufactured wood other than furniture	1,89,840	0·005	0·010	18,71,880	·047	·094
Tea chests of wood ..	..	..	..	64,28,760	2·800	5·600
Wood pulp ..	..	..	..	39,91,280	1·057	2·600
Total Broad-leaved ..	1,51,60,333	2·334	4·668	1,84,56,840	6·903	14·292
GRAND TOTAL ..	1,51,60,333	2·334	4·668	1,94,53,120	6·904	14·294

2. MINOR FOREST PRODUCTS.

Type of produce.	Exports. Value. Rs.	Exports. Quantity Tons.	Imports. Value. Rs.	Imports. Quantity Tons.	Remarks
8	9	10	11	12	13
Caoutchouc (raw) ..	1,78,38,267	10,293	1,13,120	85	Average 1926-27 to 1931-32.
Cardamoms ..	2,174,880	458	75,040	51	
Cutch and Gambier	8,07,320	2,172	8,71,400	1,895	
Bark for Tanning ..	31,973	236	16,24,160	10,526	
Myrobalans ..	84,33,960	69,773	..	..	
„ extract ..	4,27,107	1,556	6,000	9	
Gums and Resin ..	18,87,707	3,428	34,34,640	8,989	
Lac ..	5,50,79,253	29,657	17,75,120	1,372	
Turpentine ..	..	..	2,15,333	294	
Sandal Oil ..	21,01,173	65	..	..	
Nux Vomica (Strychnine) ..	27,833	2,069	..	..	
Total ..	8,90,59,973	1,19,707	81,14,813	23,221	

TABLE VII.

Summary Statement.

(Expressed as Standing Timber).

Type of Produce.	Utilisation.	Exports (Table VI, Col. 4).	Consumption of Home-grown Timber (Col. 1 – Col. 2).	Imports (Table VI, Col. 7).	Total consumption of Home-grown and Imported Timber (Col. 3+Col. 4).	Net increment (Table III, Col. 5 and 10).	Balance + or – (Col. 6 – Col. 5).
	1	2	3	4	5	6	7
	Million c. ft.	Million c. ft.	Million c. ft.	Million c. ft.	Million c. ft.	Million c. ft.	Million c. ft.
India							
Conifers ..	16	..	16	..	16	19	3
Broad-leaved ..	197	5	192	14	206	270	64
Total ..	213	5	208	14	222	289	67

UNIFORM VERSUS SELECTION.

By D. D. S.

(*In lighter vein.*)

Boom! boom!! boom!!! Another goural misses the death penalty. The marking party pauses in its work, the forest officer registers another defeat and still another bullet has been offered at the altar of the God of shikar. The work proceeds and for the time being the forest officer forgets the spacing of the future trees which he had decided just before he fired. He curses the writer of the working plan and his felling rules. But the marking is to be finished as the camp is to be shifted to the next halting place on the morrow. The selection of trees to be left as seed bearers is an intricate problem. The working plan has made about three different prescriptions in three different places and the poor marking officer is bewildered. Lengthy rules have been framed for his guidance, the present and future growing stock has been discussed, the increment—annual and periodical—has been calculated, in short everything has

been done to make him realise that he needs a refresher course and that at the earliest opportunity. The marking officer who is confronted with stern realities, and knows that the terrain over which he is trying to do shelterwood fellings, under the provisions of a working plan written by a now defunct forest officer, is not at all suited to it. But the working plan officer must have his pound of flesh, *i.e.*, his Annual Yield, and woe betide a divisional officer who dares say that the pound of flesh could not be had. The marking officer hurries through his work and stops when he has obtained the required pound of flesh. He has plenty of commonsense, but it is about 10 years since he had read his Schlich and on his way back to camp he wonders if, after all, it was not more convenient to use one's commonsense and not force forests to a system to which they would not agree. He works up and fires off a letter to his official superior. Back comes a reply referring him to a paragraph of a standing order that no divisional officer can depart from the prescription of a working plan, whatever his private opinion may be. The letter is put up with the references duly flagged and the divisional officer shrugs his shoulders and bows to the inevitable. That night he goes to sleep with very uncharitable views about all working plan officers. He falls into a troubled sleep and dreams that the trees in a few representative forests (P. B. I. areas) in his division have walked to his bedside and are vehemently protesting in a loud voice about a matter which the divisional officer fails to understand. He asks them to speak one at a time and after about two hours' questioning and cross-questioning, he gets the meaning of this most unusual deputation. It is explained to him that it is against all accepted canons of justice, equity, and good conscience to select particular blocks for purposes of reproduction. It is most cruel to select trees in one area, and slaughter them wholesale in order that young ones may be produced. They cite the instance of the human kingdom where children are produced in all countries and climes and where no selection of particular areas for production of young ones is done, where men are allowed to die a natural death, where there are no

working plans, no felling rules and above all no P. B. I. areas. In vain does the divisional officer explain that rules applicable to men could not be applicable to trees, in vain does he give them a discourse on the futility of leaving trees till their natural death, on the usefulness of timber, etc. The deputationists shake their heads and insist that the Shelterwood System and especially the P. B. I. may be abolished. At this the divisional officer suggests the Selection System which is the nearest approach to the system prevalent in the human kingdom. The deputationists give a tentative approval and promise to give a final decision after consulting their constituents. They then retire and the divsional officer falls into a peaceful slumber. Next morning when the bearer brings in the tea, he mistakes him for the leader of the deputationists, but the words *chhota hazari, sahib,* bring him to face with realities. He gets up to get ready for the daily duties, which, incidentally, include doing a selection marking. Every tree in the forest seems a living being to him and he takes extreme care in marking only the mature trees. He is still pondering over his night's dream and searches in vain for an explanation. He reviews the working of the Shelterwood System in the light of the representation of the deputation which visited him the night before and decides that if ever he writes a working plan, the Shelterwood System is coming in for a good deal of criticism. After all why force forests into systems evolved by the human mind, why not follow nature as is manifested in the human and animal kingdoms and let reproduction go on in all parts of the forest. The system that has done well before man began to interfere in the work of nature, should work well again, if man gives a helping hand in the selection of the fittest trees for reproduction and in anticipating the struggle for existence which is bound to arise in any natural system.

Thus wander his thoughts ? Lo ! a goural crosses the opposite precipice. Boom ! boom !! boom !!! GOT HIM. The forest officer gets the reward for his kind thought.

And the Conservator reading the above decides that the author's increment has again gone west.—[ED.]

REVIEWS.

THE MEASUREMENT OF STANDING SAMPLE TREES.

H. G. CHAMPION, M.A., SILVICULTURIST, F.R.I., DEHRA DUN.

Forest Bulletin No. 82, Silviculture Series.

Manager of Publications, Delhi, 1934. Price Rs. 1/2/-

The conditions of growth obtaining in a sample plot and its *surround*, which yields the majority of sample trees, progressively become less and less identical at each subsequent measurement. Not only does the density of stocking in the *surround* undergo a change

owing to the continued removal of sample trees, but also the number of truly representative trees contained in it decreases rendering the choice of sample trees increasingly difficult at every remeasurement. Two alternatives suggest themselves to overcome this difficulty in the choice of sample trees. Either the area included in the *surround* should be so large as to render the effect of the progressive removal of sample trees at each remeasurement negligible, or such methods of measurements should be adopted which dispense with the felling of sample trees altogether. While a large *surround* secures better conditions for the selection of sample trees, the errors involved being inversely proportional to its area, its size must be limited both from economic and practical considerations. Mr. H. G. Champion has, therefore, confined himself to an investigation of methods which render the felling of sample trees unnecessary.

2. During the last decade or so the measurement of standing sample trees has been in great favour at most of the experimental stations on the Continent, and Mr. Champion is to be congratulated for investigating the possibility of adapting recent European methods to Indian conditions. During comparatively recent years, however, direct measurements with ladders, climbing irons, and swing seats have been found to be cumbersome and not free from an element of danger involving loss of life. In 1931, the writer found Dr. Flury of the Swiss Research Institute measuring sample trees at Winterthur with the help of a volume table, the use of ladders (up to 24 meters in height) having been given up. Investigations are in progress at the Cotta Bau (Tharandt) to replace direct measurements by those obtained from Dr. Hugershoff's stereoscopic camera specially tested by Dr. Ing. Gottfried Müller of the Saxon Research Institute. Some experimental stations still employ means to measure trees directly but the general trend seems to be towards partially direct and indirect measurements of standing trees.

3. Among the various types of ladders employed in the measurement of standing trees, Mr. Champion found a combination of ladder and swing seat of Austrian origin most suited to Indian conditions. It is satisfactory to note that the ladder was built at the Forest

Research Institute at Dehra Dun and modifications which suggested themselves in actual practice were affected in course of time. The time factor has been carefully investigated and the extra time involved is more than compensated by the advantages of direct measurements. With standing trees, under bark measurements can be only obtained indirectly, nor can the smallwood be measured.

4. Mr. Champion has also dealt with partial direct measurements and has rightly pointed out the element of uncertainty which generalizations of the form of trees involved. Indirect measurements with various types of instruments devised for the purpose have also been tested and described in detail. While dendrometers can be trusted to give fairly accurate heights, their use in diameter measurements is of limited value owing largely to the personal and instrument errors involved. Two diameters at right angles can be scarcely ever measured, and work is impossible on a windy day. Some methods of measuring crown width have also been tested.

5. Photographic methods both plane and stereoscopic have also been referred to, only the former having been examined in actual sample plot work. Given a good photograph of a tree with linear scale included in the view the task of measuring diameters is immediately transferred from the field to the office with obvious advantages. As in other methods only overbark measurements are possible. Further investigations are in progress.

M. D. C.

A SKETCH OF THE GEOGRAPHY AND GEOLOGY OF THE HIMALAYAN MOUNTAINS AND TIBET, PARTS III AND IV.

BY BURRARD, HAYDEN, BURRARD AND HERON, 1934.

Parts I and II were reviewed in the July number of the *Indian Forester*. Part III deals with the glaciers and rivers of the Himalaya and Tibet and opens with a chapter on snowfall and rainfall, which is of particular interest to foresters as vegetation is dependent on moisture and the silvicultural treatment of our goods varies according

to their situation within or without the monsoon belt. Hill's tables of monsoon rainfall 1881 are given and his law receives some support regarding the effect of altitude on rainfall, "Whatever the total rainfall might be in Sikkim or Kumaun or Kangra, the heaviest falls would be everywhere between 3,000 and 4,000 feet. In all districts the rainfall at 11,000 feet would be found to decrease approximately to one-thirtieth part of what it was at 4,000 feet." It is presumptuous to criticise eminent authorities, but the reviewer is of opinion that this relation appears definitely to be wrong, at any rate in the parts of the Punjab Himalaya with which he is acquainted where the region of maximum rainfall lies at a much greater elevation. The authors comment on the difficulty of working out a law to predict without actual observations the rainfall, and it may not be out of place to refer to information given in Forest Department records. Hart in his Sutlej Valley working plan, 1904, and Hamilton in his Kanawar working plan, 1931, deal with the rainfall of the Upper Sutlej valley and show how within the deodar belt, *i.e.*, below 10,000 feet, the rainfall varies directly with elevation and inversely with the distance from the plains, the various mountain ranges forming barriers on each of which the S. W. monsoon clouds drop part of their contents, till towards the Tibetan border the tract is almost rainless in summer and precipitation takes place in winter in the form of snow. Rainfall depends primarily on the S. W. monsoon but is influenced by situation and by the configuration of the country, side valleys being often wetter than the main valley. Near the Tibetan border the lower slopes are barren in the extreme and grass is found only at high elevations where moisture is sufficient for its growth. The need for more rain gauges is evident and of almost equal importance is an analysis of the figures at present available.

In 1913 Sir Gilbert Walker wrote "The cold weather storms of northern India are of considerable agricultural importance; their rainfall determines largely the character of the great wheat crops of northern India, and they provide the chief part of the snowfall whose melting feeds the irrigation channels during the hotter months of the year." The authors consider that the information regarding the

retreat or advance of the glaciers is insufficient to justify any definite conclusions. Sir Aurel Stein in *Central Asian Tracks* has ascribed the drying up of the rivers draining into the Tarim basin to the melting of "fossil" ice; recently Kaulback in the *Geographical Journal* has recorded the retreat of glaciers in the Assam Himalayas. The writer has noticed that the glaciers on the Lesser Kailas have retreated since he first saw them in 1914, which is confirmed by "the oldest inhabitants." It seems difficult to account for the numbers of abandoned terraced fields in Kanawar unless one assumes that smaller snow fields now occupy the topmost slopes; in the dry zone of Kanawar cultivation is impossible without irrigation and water supplies are now insufficient to irrigate lands formerly terraced and cultivated. At Chini, so well-known to readers of Kim, a curious legend exists to the effect that in former times water issued plentifully from a spring which dried up as an enemy buried a cow's skin in it, when the spirit of the fountain flew away in the form of two doves which crossed the Sutlej and settled at Barang, and where they alighted two springs gushed out and exist to this day. The Kanawar name of the alpine pasture above Chini signifies "the white louse's egg," which may indicate the former presence of more abundant permanent snow.

River systems are well described and interesting theories of their formation are discussed. It is suggested that the Himalaya as a mountain system has not yet reached maturity.

Part IV deals with geology and although somewhat technical would well repay study by Forest Officers serving in the Himalayas.

One cannot but regret that in one's earlier service one did not keep a note book in which one recorded observations, both geological and climatical, and the reviewer would suggest to brother officers that information recorded by them might be of help to members of other services in formulating or corroborating their solutions of the many problems of the Himalayas.

The volumes are a mine of information to those interested in the Himalayas and the thanks of the Forest Service as a whole are due to the joint authors.

24th June 1934. H. M. G.

REVIEW OF WORLD'S FORESTRY.

The apparently inexhaustible energies of Dr. Franz Heske of the Saxon Forest Academy have found another outlet in the publication of a new forest periodical with the ambitious object of surveying forest progress in all parts of the world. The first number with about 60 pages appeared in October 1933 and there have been several subsequent issues; it was apparently intended to publish monthly, but it has been found more convenient to combine two monthly parts. The five parts before us include articles concerning Italy, Lettland, Estland, Russia, Jugoslavia, Manchuria, South Africa and the West African coast, as well as a valuable paper by Neumann on stock-mapping from air maps. It must be admitted that except perhaps for the last mentioned paper, there is not a great deal of importance to foresters in India, and the survey of literature is of greater interest as it gives summaries of papers in the less known languages and from the more inaccessible publications. The Review is intended to supplement the "Forstliche Rundschau" by the same publishers (J. Neumann) and costs 30 RM. annually to subscribers to that periodical, or 36 RM. separately. In the prospectus, a number of interesting articles are promised which have not yet appeared, and it seems evident that the new Review will have to be taken in by all forest libraries with any claim to completeness.

H. G. C.

EXTRACTS.

INDIAN EARTHQUAKES—THEIR CAUSES AND CONSEQUENCES.

By Sir Edwin H. Pascoe, M.A., Sc.D., D.Sc., F.G.S.,
late Director of the Geological Survey of India.

(This paper was read before the Indian Section of the Royal Society of the Arts on Friday, 2nd March, 1934, when Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.SC., LL.D., F.R.S., Principal and Vice-Chancellor of the University of Edinburgh, was in the chair. In his introductory remarks the chairman said that Sir Edwin Pascoe had been Director of the Geological Survey of India for 11 years, from 1921—32. He went to India 29 years ago, when the chairman had the privilege of being Director of the same Department; and soon after his arrival the serious earthquake in Kangra occurred. He thus began his geological work in India by investigating part of the affected area in the Punjab and the United Provinces, as one of a party under the general control of Mr. C. S. Middlemiss, who, he was glad to see, was present that afternoon. Sir Edwin Pascoe had therefore taken an interest in seismology under Indian conditions from the commencement of his service. He proposed in his paper to give some of the principles which had been established by observation made on earthquakes of the past. One thing that the audience would discover was that we still know very little about earthquakes, for we cannot yet predict their occurrence even by an hour.)

A catastrophe such as that which has recently afflicted the northern parts of Bihar and the slopes of the Nepal Himalaya makes the expression *terra firma* seem a sarcasm, and yet, in actual measurement, it is the result of an almost negligible readjustment in a very small section of the outer crust of the earth. It is the outcome of a relative movement in the rocks probably not more than a few feet in extent. The mass moved, however, was by no means a negligible quantity, and comprised a substantial section of the Himalayan range.

We may start with the assumption that any sudden and violent movement in the earth's crust will produce a tremor therein. Many people associate earthquakes with volcanic phenomena and, although such phenomena have nothing to do with the majority of seismic impulses, it is true that the eruption of a volcano, if of an explosive nature, will send out an appreciable wave of disturbance. The result is, in most cases, confined to slight local shaking of the ground, even when a large portion of the volcano is blown into the air. The earthquake caused by the explosive eruption of Bandaisan in central Japan in 1888 was, for instance, felt over a radius of only 25 miles.

An exceptionally violent eruption, such as that which blew to pieces the greater part of the island of Krakatoa in the Straits of Sunda in 1883, can produce further-reaching effects. This volcanic explosion, the most stupendous on record, hurled into the air more than a cubic mile of rock, and caused cracks in walls and the breakage of windows in Batavia, 100 miles away. The waves produced in the sea by the shock destroyed many towns and villages and over 36,000 people, and oscillations on its surface are claimed to have been perceptible at a distance of 4,700 geographical miles.

The earthquakes felt in the island of Ischia in 1881 and 1883 are believed to have had a volcanic origin. In some countries volcanic and seismic activities are displayed side by side, but it is rare to find any direct relationship between the two. The only active volcano within the Indian Empire is that of Barren Island, a few miles east of the Andaman Islands in the Bay of Bengal, and over 1,000 miles from the southern boundary of Nepal. I would hazard the statement that the tranquil sleep enjoyed for the past 100 years by this island vent has been untroubled by the convulsions which, in January of this year, reduced to ruins so many towns and villages in Bihar, Bengal and Nepal.

Another possible cause of earthquakes is the explosive outburst of gas in a petroliferous region. The Arakan coast of Burma and the islands subtending it are subject to disturbances, some at least of which seem to be connected with eruptions of gas, petroleum and mud. Such emissions have been frequently witnessed on the island of Cheduba, and new islands often appear and disappear off this coast between Chittagong and Sandoway. It is difficult to distinguish between effects of this kind and the results of ordinary folding or elevatory forces, since both are responsible for relative movement in the rocks. One cannot help suspecting that the Arakan earthquake of 1762 may have been largely the result of the escape of enormous volumes of gas beneath the sea. A highly gassy petroliferous belt extends along this coast from Chittagong southwards. The 'quake mentioned was accompanied by curious changes of level among the islands of this region. Much of the alluvial area on the east of Ramri Island showed no change, while a beach on the west coast was raised 20 feet. Various parts of Cheduba showed rises from 12 to 22 feet. In the Chittagong district the effect was of an opposite character and some 60 square miles were submerged beneath the sea. The Cutch earthquakes of 1819 seem to have been accompanied by emissions of gas. At present, it seems impossible to judge to what extent an outpouring of gas and mud may be the cause or merely the accompaniment of a normal seismic disturbance. We can well imagine an ordinary folding movement causing the liberation of imprisoned gas accumulations, in which case we might regard the earthquake as initiated by the folding movement and enhanced by the liberation of gas and the consequent subsidence of the rocks.

The great majority of earthquakes are of tectonic origin, that is, they are caused by the ordinary folding and faulting movements which have affected the earth's crust since the beginning of things. It is, as you may know, usually possible to locate more or less definitely the source of a particular 'quake. This is effected by plotting on a map the extent of the damage done at each town or village and by drawing a series of lines, known as isoseismal lines, each of which connects together places which have been disturbed to an equal degree. The result of such an effort is a series of more or less regular ellipses or circles, one within the other, the centre, which we speak of as the epicentre, lying over the underground seismic centre from which the shock originated. These ellipses or circles, therefore, mark the boundary lines between various degrees of disturbance. In the case of the great Kangra Earthquake of 1905, for instance, Mr. Middlemiss adopted a system of six such degrees. In the lowest degree effects were no more serious than cracks in walls and ceilings, in the highest degree,

nothing was left standing, everything having been levelled with the ground ; degrees 2, 3, 4 and 5 were intermediate in character. In practice such a classification is not always easy, judgment has to be exercised, and allowances have to be made for anomalies, some of which I shall refer to later on. It is rather like plotting a cyclonic storm on a map by means of barometer readings. Just as the centre of such a storm is characterised by calm, so the epicentre of an earthquake is often marked by comparative immunity, due to the fact that buildings at this point are simply rocked vertically up and down and not from side to side. Away from the epicentre a horizontal component comes into play, and it is this which brings down buildings and hillsides.

Now the seismic centre has been found very frequently to occur in the close vicinity of some large fault —a fault in geological parlance being a fissure in the rocks along which movement has taken place. It seems justifiable to deduce, from this and other confirmatory evidence, that it is a jerky movement of the rocks along such a fault which produces an earthquake.

I may remind you that the earth's crust has suffered many changes in the past, and is still being altered to an extent which, though in most places too slow to be perceptible, is in other localities unmistakably visible and measurable. Throughout the history of this globe, what in one geological period was land, became sea in the next, and *vice versa*. The layered sediments of ancient oceans have become the peaks of lofty mountain chains, and old continents have foundered beneath the invading waters of new seas.

These changes, which are especially characteristic of certain periods, are accompanied in some areas by tension in the rocks, in others by compression. In areas of tension the strain is relieved by fracture along a fissure or fault, the rocks on one side of the fault sinking and on the other side rising. The fault in this case slopes towards the side which sinks and is known as a normal fault. A jerky movement up or down a normal fault would cause an earthquake, but in India, and probably in many other earthquake countries, it is another kind of fault which usually provides a locus for a seismic disturbance, and which we will now consider.

In areas of lateral compression, the first effect of the latter is that the rocks become folded, just as a dinner napkin does when laid flat on a table and two opposite edges are pushed towards each other. This folding is very frequently localised along certain lines or belts, where the rocks become piled up in the form of a mountain range. Rocks, however, even when wet and plastic, are not so yielding as a dinner napkin and, as compression continues, there comes a stage when rupture takes place along planes of fracture or faults. In these cases, the fault slopes towards the side which rises, *i.e.*, towards the quarter from which the compressional force comes, and is spoken of as a reversed fault or thrust-plane. Continued pressure tends to push the rocks of one side up the inclined plane of the fault, over the rocks of the other side. Such a thrust fault may extend for many miles along a mountain range, and is especially characteristic of its foot.

The Himalaya is part of a continuous mountain belt whose rocks have been folded and piled by what, for simplicity's sake, we may speak of as a lateral compressional

force from the north. At certain points this force seems to have been impeded by some rigid obstruction, round which the rock-folds are seen to have been bent acutely; between these obstructive points or nodes the folds bulge towards the south. Two such obstructive nodes form the eastern and western terminations of the Himalaya in fact, have given it its individuality. They are also responsible for its arc-like shape and its convexity towards the south. At each end of the chain the rock-folds sweep very abruptly round the obstructive points which have so successfully resisted their advance, and continue as members of adjacent mountain chains. Along the southern foot of the Himalaya there extends an immense reversed fault known as "the Great Boundary Fault." Most probably it consists not of a single fault, but of a number of faults, more or less parallel to each other, and all sloping inwards towards the heart of the mountains.

The lateral earth movement of compression, which produced the Himalaya, began at the end of the Cretaceous periods, at a time characterised by severe disturbance all over the region we now know as India. After a colossal outpouring of lava through fissures in the earth's crust, the great Gondwana continent, of which the Indian region formed a part, broke up. Large masses of it sank beneath the advancing sea, and India became separated from South Africa and Madagascar, with which it had previously been continuous. Relics of the sunken portion of this ancient continent have recently been found beneath the Arabian Sea by the "John Murray Expedition." Montessus de Ballore has suggested that perhaps the dynamic process of this separation from Africa has not entirely ceased, and is responsible for the few slight earthquakes felt occasionally along the Malabar coast and particularly in Tranvancore [*Mem. Geol. Surv. Ind.*, XXXV (163)]; it was along a line approximately coincident with this coast that the fracture and faulting took place which split off that portion of the old continent now lying beneath the Arabian Sea.

The compressional movement which initiated the Himalaya in these troublous times, persisted throughout the subsequent Tertiary period and, there is good reason to believe, is still in operation to-day. By this time the rocks of the range have been folded and contorted in the most complicated way and have become hard and rigid with age and pressure. The continued compressional force from the north to-day is probably largely expended in pushing the Himalaya and its rocks up the inclined planes of the Great Boundary Fault system. For the most part, no doubt, this movement goes on imperceptibly, a small fraction of an inch at a time, especially where one of the rocks along the fault is a lubricant clay. In other places, or at other times the impulsion of the Himalayan mass up the faults does not take place so smoothly but is effected in jerks. These jerks it is which geologists conceive to be directly responsible for the earthquakes, which from time immemorial have devastated the Indo-Gangetic plain and the southern slopes of the Himalaya.

I have already alluded to the bulge of the Himalayan arc towards the south. Quite an appreciable proportion of this bulge may be directly due to an actual advance of the mountain chain along the faults. If this be correct, we should expect to find earthquake centres more frequent in the more central portion of the arc, where the bulge is biggest, and absent or rare near the extremities of the arc. A map showing

the distribution of Indian earthquakes of the nineteenth and twentieth centuries supports this conclusion. No epicentre has been recorded anywhere near the eastern end of the Himalaya, and only one near the western, and that a small one. Most of the epicentres occur along the bulging portion of the chain.

Let us go a step further. The lateral compressional force from the north is checked by the weight of the rocks which it pushes up the inclined planes of the faults, and if no other factors came into the question, it is conceivable that the time would come when the weight of the mountains would balance the compressional force and produce equilibrium. The pressure, of course, may be accumulative. We know very little about this aspect of the matter, but it seems likely that there must be a limit to such accumulation.

A very pertinent factor, however, comes into the question and affords ample explanation of the disturbance of any equilibrium temporarily produced between the compressional force and the weight of the Himalaya. This factor is the weather and the erosion of the mountains effected thereby. Supposing a temporary state of equilibrium, what would happen were the weight of the Himalaya reduced? The answer is, obviously, that the compressional force, being no longer balanced, would push the Himalaya farther up the boundary faults until equilibrium was restored. Now it is quite evident that the weight of the Himalaya is being reduced every day, and more especially during the torrential rains of the monsoon, by the agency of the weather. The scouring action of torrents and glaciers is at a maximum in a drainage system so young as that of the Himalaya, but anyone who has watched whole hillsides crumbling away during a rainstorm in the monsoon, or has seen a flood sweeping down on to the plains with its thousands of tons of silt, will have no difficulty in estimating the lightening effect on the Himalaya. The disintegrating action of water freezing in the clefts of rocks, the alternate expansion and contraction caused by variation in temperature, and the impact of rain and hail, are all minor agents in such denudation, but the land slips, the bursting dams and the roaring floods, not only remove vast quantities of material from the mountain region above the boundary fault, but deposit a large proportion of it on the plains below the fault. The mountains thus become lighter and lighter, and the plains heavier and heavier. As denudation proceeds, readjustment becomes necessary, and the mountains are pushed further up the thrust-planes. The heights of Himalayan peaks in this way probably vary from decade to decade, though the variation is not likely to be more than a foot or two.

I have already suggested that this impulsion of the mountain mass up the thrust-planes takes place for the most part in a succession of minute movements imperceptible to human faculties but in many cases recognisable by delicate instruments such as seismographs. I want to emphasise this since, if we apply the term earthquake to such minute shocks, whether recorded or unrecorded by a seismograph, we must regard earthquakes as being just as normal and inevitable in certain areas, under present geological conditions, as other ordinary phenomena which accompany the attrition of a mountain chain by natural agencies. Between the years 1885 and 1892, no fewer than 8,331 earthquakes were recorded in Japan, *i.e.*, on an average, nearly 23 a

week. These minute shocks are probably just as frequent proportionally in the Himalaya: whatever their number may be, they are, we may suppose, numerous enough to diminish largely the frequency of the destructive convulsions which startle the country from time to time.

To what, then, are we to attribute these devastating shocks? Presumably to some obstacle at certain parts of the faults, some obstructive friction which accumulates until it has to yield in a jerk or jerks of appreciable intensity. In this connection the geological map of the Punjab shows two curious embayments of the line which marks the position of the hillsides of the Great Boundary Fault, one near Kangra and Dharamsala and the other near Mussoorie. These embayments give the impression, in each case, of a lagging behind of the old rocks above the fault, as if they had met with some local impediment to their advance. If that be the case, we may conceive these two small sections of the Great Boundary Fault to be in a particularly unstable condition and, if there is any truth in what we have been supposing, ripe for a jerk forward and the production of an earthquake. One is averse to excessive theorising, but the fact remains that these two embayments coincide very closely with the two epicentres of the great Kangra Earthquake of 1905.

An earthquake appears to originate from some point or locus at some considerable depth below the surface. In the case of the Shillong Earthquake of 1897, this depth was calculated to be about five miles; in the Kangra Earthquake it was estimated to be much greater—between 16 and 20 miles. What this precisely means we do not know. Is there some actual obstruction in the Boundary Fault located at this particular depth, or is it merely the point from which the resultant of many obstructive effects along this plane acts? Confirmatory evidence as to the depth of the seismic centre is sometimes afforded by the direction of the cracks in buildings.

The horizontal width of the thrust faulting along which movement is thought to have taken place in the case of the Shillong Earthquake is believed to have been about 200 miles, this faulting occurred, not in the Himalaya, but in the Shillong plateau.

Occasionally there are signs on the surface of the movement of the rocks along the faults. Such evidence is uncommon for the reason that any relative shifting among the rocks is almost immediately hidden beneath falling debris or rapidly obliterated by denudation. This shifting, as we have seen, is not always confined to a single fault but may be distributed among a series of parallel or echeloned fractures. In connection with the Kangra Earthquake Mr. Middlemiss records a true rock fissure near Larji, showing perfectly fresh surfaces and lying along a line of faulting, as it dipped or sloped into the hillside, it did not appear to be the result of gravity but suggested fresh movement along an old fault. The Shillong Earthquake of 1897, which seems to have been a very complicated one, is thought to have been caused in the usual way by movement along a thrust-plane, but its effect was intensified by new faults of a normal character. One of these faults, wherever visible, was traced for 12 miles and probably extended much further, and showed a maximum relative displacement or throw of 35 feet; as Mr. Oldham remarks, this alone would be sufficient to account for a

very severe earthquake. A large block of granite which happened to lie across the line of this fault was overturned by it. The normal faulting in this earthquake was not all in the same direction. The great Japan Earthquake of 1891 was characterised by the development of a fault which was traced on the surface for nearly 50 miles and in places showed a scarp or cliff indicating a relative displacement of about 20 feet; the underground displacement may have been greater. This new fracture, like those in the Shillong plateau, seems to have been a result rather than a cause of the initial disaster, but its formation must have added very considerably to the general disturbance.

The duration of a small earthquake may be anything from a few seconds to a minute, but the larger disturbances may be felt for two or three minutes and affect a seismograph for from six to twelve minutes. Each jerk initiates a complicated set of vibrations which are sent out in all directions, some of them longitudinal, some of them transverse. It is the transverse or distortional waves, travelling along or parallel to the surface, which cause most of the havoc. The mean rate of travel of this wave in the Shillong Earthquake was about 120 miles per minute.

Fissuring in the ground is a frequent consequence of an earthquake and might be expected as a tensional effect following a relieved compression—a kind of rebound after an advance of the rocks. Most of the fissures are superficial effects, and many of them appear to be merely the result of the shaking and warping. Some of them look formidable enough but, as a rule, they are of no great depth and are typical of alluvial tracts. They are just as numerous in the hills above the fault as in the plains below.

The alternation of compression and tension in an earthquake area is illustrated by the effect on a railway line. Portions of the line may show buckling, due obviously to compression, while breaks in the line elsewhere indicate tension.

I have already drawn attention to the up-and-down movement experienced immediately over the seismic centre of an earthquake. This up-and-down component is especially characteristic of the epicentral tract and causes articles on the surface to jump. Where the horizontal component begins to make itself felt as well, such articles are shot into the air and fall some appreciable distance away. Mr. Oldham gives several instances of this in the Shillong Earthquake. The most striking was the effect upon a group of small Khasia monoliths, some six feet high, which had been shot upwards out of the ground. One of these had travelled through the air from the place where it had stood, to a place 6½ feet away, where a deep dent marked the spot at which its lower end had first struck the ground; the angle at which it was shot upwards could not have been much less than 60 degrees with the horizon.

The twisting of small pillars such as those forming monuments or tombstones has been noted many times, but there are so many ways of explaining this change of orientation that we learn very little therefrom. The degree of uniformity, for instance, in the previous adherence of the base of the twisted portion to the unmoved portion—or to the ground, as the case may be—would affect the motion of the loosened portion.

There are many complications in the consequences of an earthquake, some of which are not understood. One of these is the presence of what have been called

"earthquake shadows." Within a zone of disturbance are found spots where, for some inexplicable reason, the effect of the shock has been negligible or very much mitigated. The nature of the site on which such an undisturbed building stands might, of course, have a noticeable influence, but there are cases in which this factor can be ruled out.

An interesting earthquake shadow occurred in the city of Lahore at the time of the Kangra Earthquake. The Town Hall was seriously damaged by the collapse of its four massive turrets and the adjacent market buildings badly damaged by the fall of one end and part of the roof, though most of the walls in the two cases were left standing. A few hundred yards away the Law Courts, a large building covering a large area and surmounted by delicate turrets and cupolas, survived practically unaffected, the only damage visible being unimportant cracks in the interior.

A great earthquake is, for months afterwards, followed by innumerable after-shocks which gradually diminish in number. During the immediately succeeding twenty-four hours these after-shocks may be numbered in hundreds. After the Shillong Earthquake the earth in this region for days never came to rest but was in a constant state of gentle tremor, interrupted now and then by severer shocks. Two of the latter, in the words of Mr. Oldham, were severe enough to have caused great destruction in the central area had there been anything left to destroy, and were felt as far as Calcutta ; one of them was perceptible even beyond Allahabad. As we might expect, these after-shocks do not all originate from the same point, but from many points in the vicinity of the main seismic centre. At all these points or secondary epicentres, subordinate strains set up by the main shock evidently require early adjustment. It is not always easy to decide what to classify as after-shocks of a serious 'quake, and what as ordinary minute advances. The seismograph in Simla continued to record what have been called after-shocks of the great Kangra Earthquake of the 4th April, 1905, till the end of 1907. Mr. Middlemiss wrote: "With the year 1907 comparative quiescence sets in and the few shocks recorded more and more lose the aspect of genuine after-shocks. . . . . Although it is probable that the hilly region of Kulu and Simla will go on yet for some time yielding shocks that may have a connection with the big shock of 4th April, 1905, yet as time goes on, these will be confused with local ones common to the region and distant ones from other centres."

Not the least terrifying consequences of a great earthquake in hilly regions are the landslides which sweep down like avalanches on villages below. These are not always confined to the loose soil-cap and debris lying on the hill slopes, but at times include portions of the country rock which split off, leaving fresh bare surfaces, In the 1897 Earthquake such slips were caused on an enormous scale. Mr. Oldham describes the appearance of the southern face of the Garo and Khasia Hills, as viewed from the deck of a steamer sailing up to Sylhet :—"The high sandstone hills facing the plains of western Sylhet, usually forest-clad from crest to foot, were stripped bare, and the white sandstone shone clear in the sun in an apparently unbroken stretch of about 20 miles in length from east to west. Beyond this, the landslips, though still large and conspicuous, grew gradually fewer." By the same earthquake the hillsides of the small Mahadeo valley were stripped bare from crest to base. "At the bottom of the valley

was a piled-up heap of debris and broken trees, while the old stream course had been obliterated and the stream could be seen flowing over a sandy bed, which must have been raised many feet above the level of the old watercourse."

Not only are these rock falls an accompaniment of the shock itself, but a large number of them, some of considerable magnitude, follow at intervals for weeks afterwards ; for the hillsides, fissured and weakened by the shake, are at the mercy of any serious rain-storm. These storms, furthermore, are aided in their destructive work by the numerous after-shocks.

In a hilly region, especially in one of narrow gorges, the landslides, caused directly or indirectly by an earthquake, frequently form unstable dams in the streams at the bottom, ponding back the water and producing large temporary lakes, the waters of which, when the dam bursts, sweep down, carrying all before them. Sometimes two such lakes will be formed in different parts of the same stream ; if the upper dam yield first, the force of the water thus liberated will burst the lower dam, and the double flood pour down the rest of the valley.

Earthquake floods, however, are not all due to landslips ; the most widespread of them are, in fact, produced in a less violent way. They are the result of the rise of river beds, or of the subsidence below flood level of the high land bordering them. In this way large areas of lower-lying land are inundated and crops and livestock destroyed. Deviation in the ordinary drainage channels is also caused by the deposition of silt in unusual amounts and in unusual places.

In considering what measures can be taken to lessen the havoc wrought by earthquakes, the first question which naturally presents itself is : Is it possible to foretell them ? Definitely we may answer: No. We may surmise that a certain section of a large fault is in a state of strain and that an earthquake is, as it were, due. But it is not only impossible to foretell *when* the shock is likely to occur, but also to say whether or not the strain will be dissipated by numberless infinitesimal shocks of a harmless nature, spread over a period of many years, in the way I have already suggested. An interesting example of this point occurred in 1905 in connection with the Kangra Earthquake. This disturbance originated from two seismic centres simultaneously, one near Kangra and the other near Mussoorie. Between the two lay Simla, at which important hill-station very little disturbance was felt. If there is anything in the suggestion regarding the embayments of the fault-line we may imagine that the earthquake merely brought the Kangra and Mussoorie areas into a state of comparative equilibrium, which was already being enjoyed by Simla. One would be ill-advised, however, to base too much on mere hypothesis, and Sir Thomas Holland, who was then Director of the Geological Survey of India, wrote, if I remember rightly, to the Public Works Department in Simla and warned them that, by all the rules of the game, Simla might be in an unstable condition and an earthquake due there unless readjustment took place quietly and imperceptibly. Nothing happened, and Simla has pursued her untroubled course ever since. We seem to have the choice of three conclusions, alternative to the one I have already mentioned : (1) that Simla had already attained the measure of

equilibrium that Kangra and Mussocrie acquired as a result of the earthquake ; (2) that Simla was left in a state of instability which has since been adjusted by smooth movement spread over a long period ; or (3) that Simla is still in a precarious state of instability which, it is likely, has increased during the past twenty-nine years, and is threatened with a shock of some severity in the early future.

As my audience is not composed entirely of cold-blooded scientists, I am tempted to relate an experience I had in Kashmir, while investigating the effects of the 1905 Earthquake. In the town of Jammu I was taken to an old Sadhu who was said to have foretold, not only the earthquake, but the month, the day and the time when it was to take place. My amused incredulity was silenced by his production of a newspaper, printed in English and dated some days before the earthquake, in which his prognostication appeared. In black and white there was the prophecy, correct to a minute ! There may be more things in heaven and earth than are dreamt of in our Western philosophy. All I can say is : were that old man to foretell an earthquake here in London to-morrow morning, I should take an early train to a quiet spot in the country !

Preliminary shocks of a minor nature usually occur a few seconds before the main 'quake. These are thought to be the result of longitudinal waves through the deeper parts of the earth's crust, travelling faster than the transverse waves. The warning they give is effectual in isolated instances but, generally speaking, is far too short to be of practical value. It is discounted also by the ignorance of all concerned as to whether these tremors are no more than ordinary small adjustments or are the preliminaries to some greater shake. In a town like Shillong, for instance, where scarcely a week passes without one or more perceptible tremors, the inhabitants are apt to turn a deaf ear to the cry of "Wolf !"

The sounds also, which accompany an earthquake, usually commence to be heard a little before the actual shock arrives. These sounds continue during the shock and are not among the least alarming of its characters. A witness in the Assam Earthquake of 1897 records that the crash of houses falling within thirty yards of him, was completely drowned by the roar of the earthquake.

All we can do is to indicate which are earthquake areas, *i.e.*, places sufficiently close to faults along which movement may be expected to be liable to damage therefrom. Amongst such areas is the Indo-Gangetic plain, which is, unfortunately, the most densely populated part of India. The 'quake of last January, which was felt most acutely in north Bihar and Nepal, seems to have originated in that part of the Great Boundary Fault system situated in the Churia Ghati or foothills of the Nepal Himalaya. The Shillong plateau is another area of unstable faults, as is also the hilly country west of the Indus.

The damage likely to be caused by earthquakes in such areas has to be faced when any expensive constructional work is contemplated, such as the great hydro-electric project which was recently completed in the Punjab. The alternative is to forego all schemes of industrial expansion requiring apparatus and buildings, and to ignore the many natural facilities afforded by a well-watered country. The most effective remedy,

one would imagine, is the setting aside of an insurance fund at the time any such project is launched : such a financial provision should form part of the budget of the project.

With regard to buildings, Japan has, I believe, tried to circumvent the effect of earthquake shocks by various subterfuges, such as ball-and-socket joints, ball-bearings, etc. The success of these measures seems to have been limited, judging from the last Japanese earthquake, which appeared to be as destructive as most of its predecessors. In areas quite close to the centres of disturbance, probably no measures would be very effective, but further away possibilities of minimising the effects of a shock are greater. One important point that suggests itself is that there should be no loose beams or joints in the upper floors and roofs ; the fall of such loose material is a fruitful source of loss of life. All ceilings should be clamped to the joints supporting them. These are questions for the engineers. The most suitable form of building for an earthquake area, one would think, is one possessing a framework of metallic girders sufficiently pliant to bend without snapping under the impulse of a shock. Small buildings whose walls slope inwards towards the centre appear to enjoy unusual immunity, as witness the hill temples, some of which must have survived more than one serious shock.

Of all the violent moods which Nature from time to time takes on, the earthquake is the most terrifying, the most destructive and the least predictable. I should like to conclude this paper by reading to you the opening lines of Mr. Oldham's memoir, the very restraint of which will bring home to you the ferocity of the shock and the appalling havoc wrought thereby.

"At about quarter past five in the afternoon of the 12th June, 1897, there burst on the western portion of Assam an earthquake which, for violence and extent, has not been surpassed by any of which we have historic record. Lasting about two and a half minutes, it had not ceased at Shillong before an area of 150,000 square miles had been laid in ruins, all means of communication interrupted, the hills rent and cast down in landslips, and the plains fissured and riddled with vents, from which sand and water poured out in most astounding quantities ; and ten minutes had not elapsed from the time when Shillong was laid in ruins, before about one and three-quarter millions of square miles had felt a shock which was everywhere recognised as one quite out of the common."

All I need add to that is that the earthquake of 1905 was no less intense. (*Indian Engineering, May* 26, 1934.)

THE RELATION OF LEAF SIZE TO ROOT STRUCTURE IN TRIFOLIUM REPENS.

BY G. H. BATES.

Mechanical Influences upon Root structure and Leaf size.

In any observational studies of grassland communities the variation in the leaf size of *Trifolium repens* in different situations is very striking. The relation between this phenomenon and habitat is clearly apparent and is therefore of interest from the ecological point of view. The economic value of *T. repens* needs no emphasis: this

species is the criterion of good pasture in the eyes of the grazier, and any factor affecting its productivity or competitive powers demands attention.

It is well-known that leaf size is one of the distinctions between ecotypes of this species, but that the characteristic is not purely genetic is obvious from the fact that a change of habitat produces a change in leaf size in the same ecotype. If two ecotypes, distinguished by a different leaf size, are removed to a fresh habitat, the increase or decrease in leaf size induced upon them by the new habitat, is, to a large extent, of the same proportion in both cases.

Observation shows very clearly that close cutting or grazing reduces leaf size, this being very noticeable in the case of lawns, where mowing is frequent, or on sheep walks in the regions of closest grazing. The same result is produced by treading, the effect of which is to remove leaves by damage, and thus act in much the same way as cutting or grazing, and in addition to consolidate the soil surface.

It is noticeable also that when runners proliferate from a dense colony of *T. repens* to an unoccupied area of ground and there establish fresh shoots, the leaves of these shoots are of greater size than those on the centre of the colony. This latter pehnomenon may even be observed when a runner establishes a shoot upon a denuded worm cast in an otherwise dense turf.

It is a fact now generally accepted that the effect of denudation of foliage is to reduce the size and extent of the root system (1). The result is produced by the restriction of photosynthesis and the consequently reduced food supply to the underground organs. It is obvious that a restricted root range will entail a limited water supply, and it is reasonable to assume that this deficiency may result in an automatic diminution of leaf size. This will explain the observations described above.

Experiments.

To investigate the problem of leaf size in relation to root system, a series of four experiments was conducted in the years 1929-32, the same results being recorded in each instance. The work was carried out in the following manner : -

In each case a garden soil was utilised, in the first two instances a heavy loam (Chesterfield, Derbyshire), and in the last two, a light loam (King's Lynn, Norfolk). In both cases the soil was neutral in reaction as the result of frequent liming.

Ten strips of *T. repens*, each 1 m. long, and containing the same quantity of seed, from the same source, were sown each year. The ten strips represented five treatments. each in duplicate, the position of each strip being randomised. It was thought that the above arrangement, and the fact that the trial was conducted four times in four different years, would obviate the possibility of soil or seasonal differences.

The treatments chosen were as follows :—

Strips 1 and 1a (control).—Strips sown and left undisturbed throughout the season.

Strips 2 and 2a.—In this case the seeds were sown in normally loose soil and allowed to become established as seedlings. The soil was then consolidated by treading.

care being taken not to injure the seedlings. After consolidation the plants were allowed to grow undisturbed.

Strips 3 and 3a.—Trodden and bruised by the foot at weekly intervals, commencing two months after sowing.

Strips 4 and 4a.—Cut at weekly intervals commencing two months after sowing.

Strips 5 and 5a.—These were laid down in the following manner. Containers were constructed from sheets of perforated zinc, each being 1m. long by 10 cm. wide and 10 cm. deep. The containers were fitted with handles, filled with soil, and embedded in the earth. The seed was sown down the middle line of the container in the same manner as with the other strips. Eight weeks after sowing, the plants were lifted in the containers at weekly intervals and any roots which had emerged through the perforations in the zinc (usually a large crop) were shaved off. The containers were then replaced in the soil. In this manner root range was directly restricted without interference with the foliage.

Results.

In each year the following results were obtained :—

Strips 1 and 1a (control).—The growth was luxuriant and the leaves of large size. Had these plants been usually observed in the field they would have been regarded as " commercial " white clover and not as " wild " white clover. The root system was well developed.

Strips 2 and 2a (consolidated soil).—No difference was noted in comparison with the control as regards leaf size.

The root system was as well developed as in the case of the control, except that there was no growth of secondary roots in the first 2 cm. depth of soil. It was also noticeable that the runners did not establish roots as freely as in the case of the control, where the surface soil was loose.

Strips 3 and 3a (trodden).—The results were similar to those obtained by cutting, but the reduction in leaf size was not quite so great. This is accounted for by the fact that treading and partial injury of the leaf does not reduce photosynthesis so extensively as the removal of the entire leaf by cutting. Root range was again restricted, but it was impossible to give any measured comparison with the root range of the cut plants.

Strips 4 and 4a (cut at intervals).—Great reduction of leaf size was shown in comparison with the control. The number of plants did not diminish, nor was there any significant difference in the number of leaves. Root range was restricted.

Strips 5 and 5a (root pruned only).—A great reduction in leaf size was effected, comparable with that noted in the case of the strips which were cut at intervals. The root range was obviously restricted, but the pruning produced a compratively dense growth of secondaries. The number of leaves was less than in the case of the cut plants (strips 4 and 4a) and the difference appeared to be significant.

Observations showed the same result in each year. In 1932 it was decided to obtain a definite measure of comparative leaf size. This was carried out in the following manner :—

Leaves were cut in bunches, at the ground-level, from each of the strips. The cuts from each were placed in separate receptacles and later the produce of each strip was mixed with that of the duplicate. From the five receptacles 100 leaves were picked in succession from each of them thus giving 100 leaves from each treatment. The leaf area was measured by placing upon graph paper, tracing round the margin, and counting the number of squares covered by each leaf (1 leaf—3 leaflets). The orthodox method was adopted, *i.e.*, less than half a square was neglected, more than half a square was counted as one square. The result of these measurements are set out in Table 1 below :—

TABLE I.

Strips.	Treatment.	Average area of leaves, sq. mm.	Range of leaf area, sq. mm.		Average area expressed as %
1 and 1*a* ..	Undisturbed (control) ..	627	75	1,260	100·0
2 and 2*a* ..	Consolidated soil ..	603	68	1,184	96·1
3 and 3*a* ..	Trodden weekly ..	409	75	910	65·2
4 and 4*a* ..	Cut weekly ..	263	62	734	41·9
5 and 5*a* ..	Root pruned ..	244	60	750	38·9

The establishment of shoots from runners made the identification of individual plants difficult, and as estimations would have been inaccurate in consequence they were not carried out. Increase of individuals by runner establishment may have been greater in some cases than in others ; but in no case did a treatment reduce the original number of individuals.

Discussion of results.

Taking the strips 1 and 1*a*, which were grown in a normally loose soil and left undisturbed throughout growth, as a control or standard, it will be noted that the other treatments had a marked effect upon leaf size.

In the case of strips 2 and 2*a* the reduction of leaf size cannot be regarded as significant in comparison with the control. The fact that no significant decrease in leaf size can be noted may be explained by the fact that treading produces consolidation in the first 2 or 3 cm. of soil only, below this level the density of the earth is comparable with that which is unconsolidated. The clover is able to force the strong tap root through this surface layer, and to spread its deep root system through the lower soil. It appears that the only effect of this surface consolidation is the restriction of the development of secondary roots in the region of this layer and the difficulty in establishing adventitious roots from runners, owing to the hardness of the soil surface. The root system as a whole was almost as well developed as in the control.

In the case of other species such as grasses or other shallow rooting plants, this consolidation of the top layer of soil may restrict root range and leaf size. It has been shown (2) that where the soil has been consolidated to a depth of 40 c.m. the whole plants of the several species grown were restricted in growth.

Strips 3 and 3*a* showed the same result from treading the leaf as from cutting, though the reduction in size was not so great. The difference is probably explained by the fact that crushing by the foot does not effect so complete an obliteration of leave as does the cutting, though this depends on the intensity of the treading.

In the case of strips 4 and 4*a* the effect of cutting had a very rapid effect on leaf size. After the first cutting the second crop of leaves was smaller, and there was a steady but diminishing reduction after each subsequent cutting. Root range was restricted in development to greater extent than in any other treatment.

The fact that in the case of strips 5 and 5*a*, where the plants were root-pruned only, there was a great reduction in leaf size comparable with that produced by cutting at weekly intervals, is of great significance. The result points to the fact that reduction in leaf size is not directly due to cutting or crushing of the leaf, but to the subsequent effect on root range and water supply which in its turn automatically reduces leaf size.

In the case of the root-pruned strips the root is directly restricted without interference with foliage, but it is obviously impossible to reverse the process, *i.e.*, to cut or crush the foliage without restricting root range, and it can therefore never be more than an assumption that cutting or crushing has no direct influence upon leaf size. But the effect of root-pruning does definitely prove that root restriction can be fully responsible for diminution of leaf size, apart from any direct mechanical influence upon the leaf. As leaf size is reduced by root-pruning to as great an extent as by cutting or crushing it does point to the fact that these latter processes do not reduce leaf size by any direct means.

It is worth noting that the different sizes of leaf on any clover plant, arbitrarily placed in two groups, large and small, exhibit a distinct stratification, *i.e.*, an upper stratum of large leaves and a lower stratum of small leaves. It might be argued that the influence of cutting or treading in reducing leaf size simply depends upon the removal of the upper layer of large leaves; but this is disproved by the fact that root pruning also inhibits the formation of this upper stratum.

II. Soil Acidity and its Influence upon Root Structure and Leaf Size.

Influence of Soil Acidity on Root Structure.

It has been known for some time that *T. repens* tolerates a high degree of soil acidity (3). Observations upon very acid soils in the midlands and north of England showed that plants growing upon these soils possessed a comparatively smaller leaf than upon an alkaline soil, but there were a few puzzling exceptions.

On examining root structures it was noted that in some cases the whole root system was restricted in size, while in others it appeared to be better developed in some regions of the soil than in others—in other words to exhibit stratification.

In many soils there is a definite stratification of soil acidity due largely to biotic influences. Acidity may be more intense in the surface layers of the soil, owing to the formation of acids in the surface layer of dead root material or "mat," and the CO2 from living roots. In industrial districts acid fumes may be the cause of this surface acidity, and may also assist indirectly in the formation of "mat."

Sometimes the acid surface layer is ploughed completely under, thus forming an acid stratum at some depth below the surface. Acid pans may also produce this effect.

Where liming has been carried out the surface layer of an acid soil may become alkaline or neutral in reaction in consequence of the liming.

A soil may also be acid throughout.

On examining root systems in the field, and at the same time making field tests of the intensity of acidity of the different layers of soil by means of soil indicator (approximate pH value determined by B. D. H. Universal Indicator); it was noted that the root system definitely reacted to the acidity of the soil at different depths. Root development was restricted in the most acid layers, and comparatively better developed in the alkaline, neutral, or less acid layers of the soil. There was also a definite inhibition of nodule formation in the most acid layers.

Experiments.

The stratification of soil acidity was never sharply defined in the field and no strict line of demarcation could be drawn. In many cases the pH value of one layer did not exhibit a wide range of difference from that in another. For this reason one could not take any measure (photographically or otherwise) of the corresponding stratification of the root system, but observation left no doubt as to its existence.

To confirm the above observations and produce definite evidence, experiments were set up as follows:—

In the year 1928 plants of *T. repens* were grown in a garden soil of neutral reaction (pH 7 approx.) into which layers of very acid soil (pH 3 approx.) were introduced. The acid soil was, as nearly as possible, of the same physical texture as the alkaline. Both soils overlay Coal Measure shale, but the neutral soil owed its condition to frequent and heavy liming. The experiment was not carried out in pots, as this leads to a felt-like formation of root fibres against the surface of the pot. Garden borders were utilised.

When the plants had flowered and the seed formed, their root systems were examined by the following method. The plants were excavated, with the block of soil in which the roots were growing preserved intact. The block was wrapped with fine-mesh netting and pierced with wire skewers, to keep the roots in place. After the soil had dried it was shaken gently until all the particles fell away from the roots, any lumps adhering to the roots being crushed with the fingers. (The system of washing out the roots, adopted by some workers in the U. S. A. and U. S. S. R., was found impracticable, as it resulted in a felting together of the secondary roots.)

In the following year a similar experiment was carried out with the same results. The effect in the root systems of plants of *T. pratense* was also observed and the same reaction was noted.

A further trial was carried out in 1931 on a sandy soil (approximately pH 6, with a lime content of 0·40 Ca CO3) into which layers of sandy acid soil (pH 3 approx., lime requirement 0·063 per cent. CaO) were introduced. In this trial dense patches of *.repens* were grown by heavy seeding.

Influence of Soil Acidity on Leaf Size.

Observations in the field showed that where an alkaline surface layer overlay an acid soil the germination and establishment of *T. repens* and other cultivated plants was vigorous. It is now a generally accepted fact (4) that in the case of several grasses a thin layer of neutral or alkaline soil is sufficient to stimulate germination and establishment on an acid soil. In the case of the establishment of *T. repens* under these conditions the plants in the early stages were vigorous as compared with those grown in an all-acid soil. This was demonstrated experimentally in pots, and is observed in practice. It was noted, however, both in the field and in the pot experiments, that when a drought ensued, the plants withered, the larger leaves died off, and a smaller-leaved plant resulted, comparable with that grown in an all-acid soil. On examination it was found that the root system had largely developed in the alkaline surface soil, apparently at the expense of the root range.

When an acid layer occurred at a certain depth, the leaf size did not appear to be affected. The root range, as a whole, suffered no restriction, except in the acid layer itself, where there was little development of secondaries.

Experiments were set up in 1932 to confirm these observations, and to obtain definite data with regard to leaf size.

Plants were grown in (1) acid soil with a neutral surface layer, (2) neutral soil with an acid surface layer, (3) all acid soil, (4) all neutral soil: strips 1 and 1a of the previous section of this work were taken as an example of an "all neutral soil." This was the neutral soil used in (1) and (2) in this paragraph.

The figures set out in Table II show the differences in leaf size, the estimations being made in the manner previously described:—

TABLE II.

Example.	Soil.	Average size of leaf sq. mm.	Range of leaf area sq. mm.		Average area expressed as %.
1	Acid soil neutral surface ..	320	65	763	51·0
2	Neutral soil acid surface ..	369	58	983	58·8
3	All acid soil ..	280	61	808	44·6
4	All neutral soil ..	627	75	1,260	100·0

In example 1, leaf size was reduced in comparison with example 4. In example 2, which was checked in growth in the early stages owing to germination taking place in an acid medium, some relative reduction was noted, but in example 3 the leaf size was as much reduced as in example 1.

SUMMARY.

It is shown that restriction of leaf size may be produced by the mechanical operation of cutting or crushing the leaf. These actions interfere with the nutrition of the root, thus affecting root range. A restricted root range results in a limited water supply, which automatically produces a smaller leaf, and consequently a smaller area of transpiration. Direct root-pruning produces the same phenomenon.

Soil acidity may occur throughout the whole of the soil, or in strata. When acidity restricts root development, leaf size is also reduced, in proportion to the degree of root restriction.

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INDIAN FORESTER

OCTOBER, 1934.

THE FOURTH SILVICULTURAL CONFERENCE.

The last Silvicultural Conference was held at Dehra Dun in 1929, five years ago. It was proposed last year to call only an informal meeting of Silviculturists in 1934, but as all Provinces finally agreed to send representatives and a comprehensive list of subjects was received for discussion, it was recently decided to hold a full meeting in the week beginning October 29th, 1934. All provincial Silvicultural Research Officers are attending and several territorial officers are also expected to be present, including representatives from important States. A Programme and the Agenda of the Conference are published elsewhere in this number.

While it is fully realised that it is difficult for many officers to attend, in particular for those serving in the outlying Provinces, the occasion can be taken advantage of by many officers who have not seen the Forest Research Institute before, and those who cannot make it an official visit would find it worth their while to come on their own and combine business with pleasure. It is deplorable that more Forest Officers do not visit the Forest Research Institute. We know the case of one Forest Officer who used to visit the Institute once every year, mostly at his own expense and we know that he obtained good value from such visits. We quote *in extenso* from the report of Forestry Committee published in 1929 which emphasized the importance of such visits both to the forest officers and to the Institute :—

" We think it desirable that Provincial Silviculturists and Working Plans Conservators should visit Dehra Dun at least once in every two years, and that other provincial officers, even if they are not

definitely engaged in research work, should be encouraged to visit the Institute in order to gain some idea of the scope of the work done at Dehra Dun. There can be no compulsion about these visits; but we believe that if the Provincial Forest Departments realised the benefits that would accrue from them, they would give more opportunity to the officers under their control to come to Dehra Dun and study for a while certain aspects of forest work with which they might never otherwise become acquainted."

"The maintenance by the Institute of close touch with forest officers is no less important than contact with the business world. We believe that the most effective method of establishing this touch is for forest officers themselves to visit Dehra Dun and see the activities that are in progress there. The staff of the Institute would benefit from such visits, for their attention would be attracted to difficulties or possibilities perhaps unrealised before, which had presented themselves to officers in the course of their daily life in the forest. But the advantage to provincial officers themselves would be yet greater. They would realise the broad scope of the work of the Institute. They would realise that the Provinces could not fail to derive benefit from it; and they would realise that members of the staff of the Institute were in a position to give not only information. but also helpful advice on most subjects connected with forestry. We have suggested, in connection with the co-operation of the Central Silviculturist with the Provinces, that even those Provincial forest officers who are not definitely engaged on research work should be encouraged to visit Dehra Dun as much as possible; we know that they will be welcomed there; and we trust that Provincial Forest Departments will realise the advantages of encouraging them to go."

The views of the Government of India on the subject are set forth in their letter addressed to all local Governments and administrations in July, 1912, extracts from which are quoted below :—

"The Government of India consider it is of great importance that all gazetted forest officers should be in touch with the Research Institute and keep themselves acquainted with the work and investigations which are in progress there, and though deputations for

special study have not yet been arranged for, they would be glad to see all promising officers encouraged to pay short visits to Dehra, of say, ten days or a fortnight, during which time they would be able to inspect the Museums, the Chemical Laboratory and the Herbarium. They would thus gain a general knowledge of the investigations which have been and are being undertaken—and of the widespread effects that these may be expected to have on the silvicultural treatment of the forests and on the development of forestry in general.

Should it be considered desirable that an officer should pay a more extended visit to Dehra for some particular purpose or with some special object, *e.g.*, to consult the herbarium in connection with the preparation of a local 'Flora,' it will be open to local Governments to allow him to do so, and the President, Forest Research Institute, will endeavour to give him every facility for prosecuting his enquiries. During such period of deputation officers would receive their full pay and allowances, and may be allowed travelling allowance to and from Dehra Dun, but no daily allowance during halt there."

We fully realise that there are difficulties, primarily financial, and in this age of depression many Provinces would find it hard to provide money for such visits, but we consider that it should not be difficult for each Province to send a few officers annually to the Institute. Thus in course of time it would be possible for every officer to visit Dehra Dun, say once every seven years, so that he can be in touch with the research work going on in the Institute.

We hope that at least some of the officers who have not visited Dehra Dun will manage to come, preferably during the days the Silvicultural Conference is held, and we can assure them that they will not regret the visit.

LIFE IN A HIMALAYAN VALLEY.*

BY E. C. MOBBS, I.F.S.

I.—The Tons Valley and its People.

The greater part of the southern side of the main ranges of the Himalayas which lies within British India is well mapped and generally considered as "known." Yet although there is little to attract explorers, there are many areas in the Himalayas under the British flag which have been so far little affected by the waves of western influence. These are areas where even the kerosene oil tin, the dandelion of western influence in the East, has scarcely begun to penetrate, and where life is much the same now as it has been for centuries and centuries.

The Tons Valley, tucked away beneath the snows, is such an area, where live a people little troubled by the affairs of the rest of India. It is an area rarely visited by white men, save for the forest officer whose lonely task is the care of the mountain forests, or for a very occasional sportsman in search of chamois, bear or wild sheep. An area where a man may have six fathers and be only one-fifth of a father himself!

The Tons river rises in the snows on the southern side of the Great Himalayas between the Sutlej and the Jumna, or more generally, about midway between Kashmir in the west and Nepal in the east. The upper half of the river rushes westerly and south-westerly in a definite valley between spurs from the main snowy ranges, and it is this part of the river basin that I call the Tons Valley, and to which this article refers. The lower half of the river turns southward and cutting for itself a series of gorges, the river passes through the parallel ranges of the Lesser Himalayas. Finally it empties itself into the Jumna river at the western end of the Dehra Dun, a wide sub-montane valley between the Himalayas and the fringing Siwalik mountains.

The outermost ranges of the Himalayas rise steeply from the forests of the Dehra Dun and are very barren on their southern aspects,

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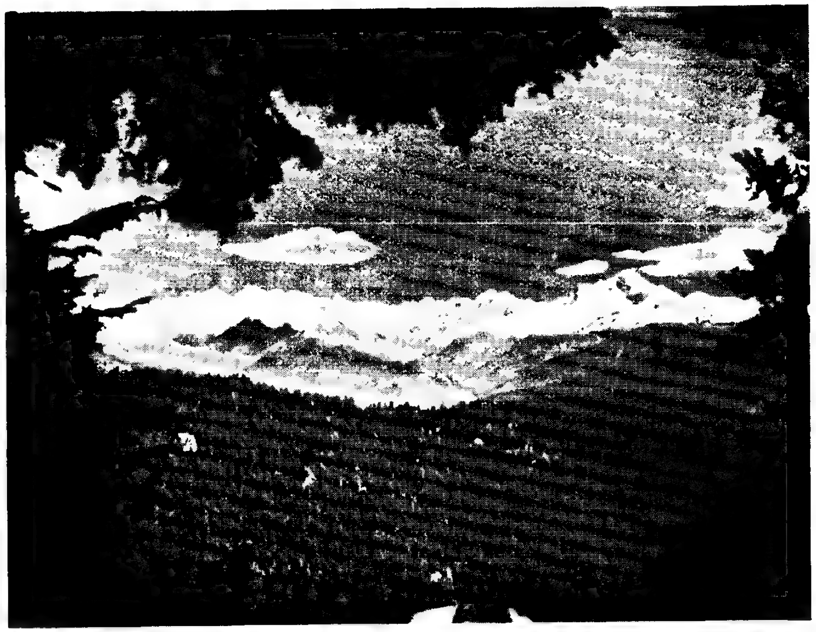

1 (above). The Tons rises in the snows of the Great Himalayas.
In the centre of the picture the main valley of the Tons can be seen stretching up to the snows. The highest mountain on the right is Sargaroin (20,370′), locally known as *Chausingha* (four horns) on account of its four peaks.

2 (right). Deep gorges have been cut by the Tons River on its way through the Outer Himalayas to the plains.

Photos by E. C. Mobbs.

making their general appearance uninviting. And until recent years the Tons and the Jumna have been unbridged and the gorges of the Tons have been almost impenetrable. These factors, combined with the great difficulty of getting about in the mountains, even when one has penetrated a little way, have for centuries kept strangers out and the local inhabitants in. And this, coupled with the vast differences between conditions of life in the Himalayas and in other parts of India accounts for the great difference in the people themselves, as compared with the Indians of the plains.

The villagers of the outer hills are gradually becoming accustomed in a timorous, wide-eyed way to modern advancements. A motor road has been cut some way into their territory to the military hill station of Chakrata. Some have even experienced the thrill of riding in a motor car, or what was once a car, for Henry Ford himself might find it difficult to recognise some of his products near the end of their days on the Chakrata road !

But this only applies to the outer hills of the area known as Jaunsar-Bawar. Beyond, few villagers have ever journeyed to the plains, and in the Tons Valley the great majority of the people have never seen even a cart, much less a motor car. They live as their forefathers did, worrying little about external events and maintaining their own peculiar habits and customs.

The greater part of the Tons Valley is in Tehri-Garhwal State, but a small portion in the south-west belongs to Jaunsar-Bawar, which is directly under British rule. This is only a small part of Jaunsar-Bawar, the greater part of which lies east of the lower half of the Tons river as it cuts southwards through the Lesser Himalaya ranges.

There are many differences between the inhabitants of the two districts—the Tehri-Garhwalis and the Jaunsaris. The boundary between the two districts is only a small stream, but it is known as the Khunigad, or the Valley of Blood. Legend has it that there was once a great battle between the two peoples in this valley. Consequently they very rarely intermarry and are distinct in many minor ways. But the boundary between the two districts is more artificial than

natural, and there is much in common between the two peoples, in the country they inhabit, and in their lives, customs and beliefs. So far as the Tons Valley is concerned, therefore, Jaunsar-Bawar and Tehri-Garhwal must be treated as a whole, although the greater part of Jaunsar-Bawar, apart from the Tons Valley, will not be referred to.

The population of the Tons Valley is very sparse, although in some places several villages may be close together. The chief reason is the steep nature of the ground, which rises rapidly from 3,000 feet at the lower end of the valley, to high ridges running from 10,000 feet to the main snowy ranges, which are over 20,000 feet. The steep slopes are mainly forested, although exposure, combined with constant grazing, has kept some of the southern aspects bare. Above the limit of tree growth, there are extensive alpine grass lands, especially in the upper reaches of the Tons Valley; but these are uninhabitable, being free from snow for only a few months of the year.

The villages are situated in places where terraced cultivation is possible, or in the valleys where there are occasional small stretches of cultivable soil. The total space available is, however, small, and this has necessarily limited the expansion of the population.

A village is usually quite a small affair. A few have forty or more houses, but most have only twenty or so, and a good many have even less. In the lowest parts of the valley, where winter conditions are not severe, some of the houses are poor constructions of hewn wood, tree branches and mud plaster. But throughout the rest of the area the houses are very substantially built. Timber is easily obtained and strong constructions are necessary to stand the winter snows and the occasional earth tremors.

A typical house is essentially a cubical or rectangular box, fitted with a sloping roof. The walls are generally built in layers consisting of stout beams of deodar (cedar) or pine timber, often a square foot or more in section, alternating with layers of masonry of hewn rock and mud plaster. The beams of one side rest on the beams of the two adjacent sides, so that the framework and stability of the house depend entirely on the beams, the masonry being simply a form of packing

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3. The villages are situated in places where terraced cultivation is possible.
Chiwan villages in the Kotigad valley, at about 7,000 feet.

4. A typical house in the Tons Valley.
The people live upstairs and their sheep, goats and cattle are accommodated on the ground floor. The alternate layers of wooden beams and rough masonry are painted reddish brown and light grey.

Photos by E. C. Mobbs.

between them. It is through custom that the present people construct their houses in this form, but there is no doubt that the origin of the style was the need of a structure that would stand the earthquakes and tremors that occur fairly frequently in the Himalayas. The layers are usually painted with coloured clay obtained locally, the beams a reddish brown and the masonry a light grey, so that from a distance the horizontally striped houses look very gay and attractive.

The roofs are not so substantial as the walls of the houses. The people do not know how to saw timber, the beams they use being axe hewn. So for the roofs they use the slabs of wood and bark hewn off the trees in the preparation of the beams. These slabs are naturally somewhat irregular in shape and so have to be placed two or three thick to make a water-tight roof. A roof thus formed has often to be weighted with rocks to prevent the pieces of wood from being blown away. It looks very crude and unsound, but actually it is very efficient in its main duty of keeping the wet out during the monsoon rains and the winter snows.

In a few villages slate or flat slabs of quartzite, found locally, are used for roofing. The pieces are mostly small and irregularly placed, but really good roofs are sometimes made, a good example being Gangar village temple, for which very fine large rectangular slabs of a fine grained banded quartzite, the banding being due to muscovite and viotite mica.

A typical house has a ground floor and an upper storey, the latter usually having a gallery or verandah running all round the house. Some houses have two upper storeys, each with its own gallery. They are all alike in that each floor comprises only one room. The ground floor is reserved for animals—sheep, goats and cattle. The people live immediately above the animals, and if there is still another floor, it is used as a store room.

To the uninitiated it might appear undesirable that the people should live immediately above their animals, especially as the ground floor is cleared out only once or at most twice a year. But

there are many advantages. Space is, of course, a very important factor, and it is necessary to have closed building for the animals, both for protection from the cold and from prowling leopards, and for the preservation of the litter. Animal manure is very important for the fields, the surface soil of which is impoverished by the leaching effect of rain and snow. The manure is applied once, or at most twice a year, and all available supplies are reserved for this. Were open pens used for the animals, the litter would have to be removed and stored to protect it from too rapid deterioration in the open air. How much simpler is the present system, in which the ground floors of the houses have simply to be cleared out once or twice a year, no other work being necessary! Then again, in those villages where there are heavy falls of snow in winter, it is much easier to feed the animals with stored grass when they are immediately beneath you than if they were some distance away. Also, on the cold nights, it is possibly warmer for the people as well as for animals if they are all in the same building.

It is surprising to find that the upper storey is a single room, as these people have the joint family system so typical of India as a whole. Father and mother, with their sons and married daughters, their sons' wives and their children, all live together in the same room, till it becomes unbearably overcrowded, when someone has to separate off and establish a new house. I have been amazed sometimes at the number of people living together in the same house. Of course, there is no furniture. What need is there of chairs and tables when God has given you the good floor to squat or lie on? There is nothing in the one room beyond the food and cooking utensils, and few spare clothes and jewelry reserved for special occasions, and perhaps a few small agricultural implements and other odds and ends. So the accommodation is limited only to the number of people who can lie down together at night. Bedding does not take up much room, as it consists simply of a thick homespun blanket, or perhaps two. If it is a fine day, all the bedding is thrown over the side of the gallery as soon as the people get up in the morning.

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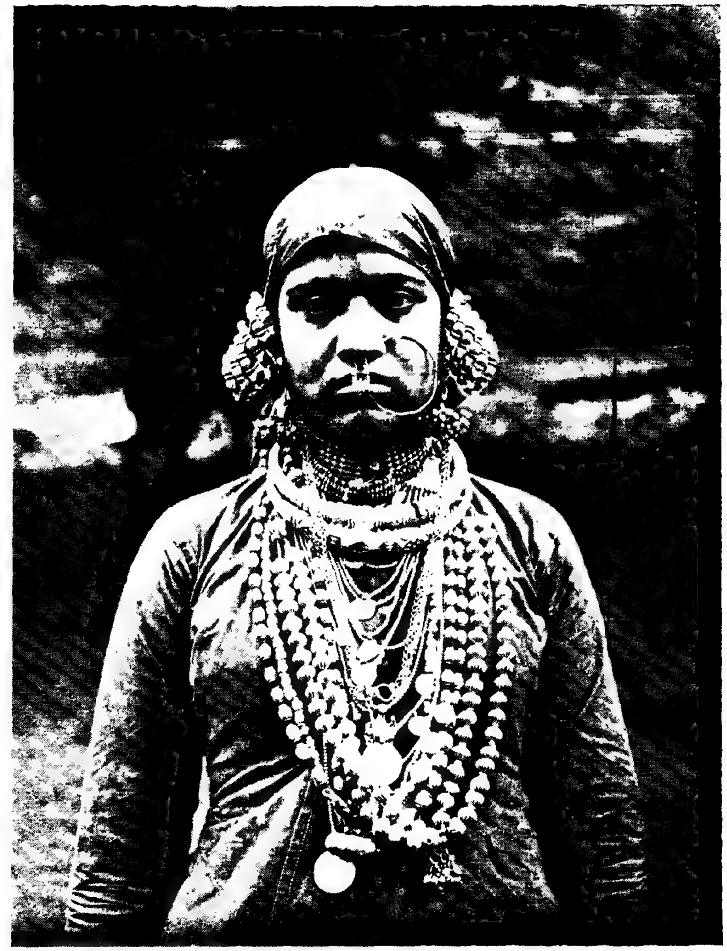
5. A Jaunsari girl in holiday attire.
The special clothes for holidays in the lower part of the Tons Valley consist of a bodice and a brightly coloured skirt.



6. Jaunsari jewelry is often of a fanciful nature.
The total weight is often as much as a woman can bear, especially when the heavy solid silver collars are worn.

Photos by E. C. Mobbs.

The clothes of the people are mainly made from homespun wool, while their blankets are made from wool or goats' hair, or a mixture of the two. But cotton materials, purchased from the one little shop of the district, or from itinerant traders, or from the warmer parts of Jaunsar-Bawar, where cotton is grown, are also used to some extent, especially in the lower parts of the Tons Valley.

A double breasted long coat, a pair of trousers and a small woollen hat constitute usually a man's wardrobe. The only additional clothing for cold weather is a blanket and a pair of home-made grass or woollen shoes. In Jaunsar-Bawar the men have somewhat different fashions. Many of them wear a very scanty cloth, not more than a few square inches, tied round the loins, and a short woollen cape or coat, the latter often being discarded altogether in the warm weather. Their little hats with rolled up brims, stained dark brown with walnut juice, are also peculiar to themselves.

The women, true to their sex, have a greater variety of fashion and a bigger wardrobe than the men. In the upper parts of the Tons Valley their clothes are very similar to those of the men in that they have thick woollen double breasted coats. But the coats are a little longer and more voluminous than those of the men, and the women have woollen leggings instead of trousers.

Lower down the valley, various types of clothing are met, varying from wool and cotton to all cotton, the latter usually consisting of a voluminous skirt and a tight fitting bodice. Head gear consists of anything from a small coloured or black cloth, placed simply over the head, to long cloths wound like turbans. The *sari* of the women of the greater part of India is quite unknown in these parts and would, of course, be useless where warmth and freedom of movement in the mountains are essential considerations.

Nearly all the women have special clothes for high days and holidays, except in the uppermost parts of the valley, where conditions are harder, the people are poorer, and homespun wool forms the only article of clothing. The special clothes comprise usually a bodice and skirt, the latter usually brightly coloured, often blue with a wide patterned border of bright red at the bottom. From a distance,

the women arrayed in their special clothes and all their jewelry looked very attractive, but at close quarters the clothes are often seen to be of very poor quality.

Some of the people are comparatively well dressed, while the clothes of others are extremely ragged. This at once distinguishes the two main classes of the people. The upper class people are usually Rajputs or Brahmans. The lower class people are called Koltas. They are not the same as the outcastes or depressed classes of other parts of India ; they are the bond servants of the upper class people, for whom they have to work without reward. Sometimes a Kolta has fields and a house of his own, but he and his family still have to work for their master, and they rarely get sufficient of this world's goods to be able to clothe themselves at all well. In other cases, the Koltas have no fields or houses, but live with and are kept entirely by their masters, who are not usually too generous. It is impossible for a Kolta to change his class : he and his children must remain Koltas for ever. Some few, however, have managed to acquire a little wealth by working in the forests in such spare time as they can find.

Jewelry, with the women at any rate, is almost an article of dress, and the style varies considerably—almost from village to village. It is usually of pure silver, but in parts a small gold nose ring distinguishes the upper class women from the Kolta women, who are not allowed to wear gold in any form. In Jaunsar-Bawar the jewelry is fanciful and includes necklaces of different shapes and lengths, ear jewelry, nose rings, head chains, bracelets, anklets, and rings for the fingers and the toes. With all her jewelry on, a woman has a very great weight to carry. In Tehri-Garhwal the jewelry is much plainer. The necklaces are often simple chains of silver, to which many silver rupee coins are attached. A large nose ring, often very large, denotes marriage in some parts. Quite a considerable amount of wealth is often carried in the form of a very thick collar of solid silver.

The weight of the ear jewelry frequently causes disfigurement. The lobes of the ears are greatly extended and the tops are completely pulled down. The piercing of a girl's ears with holes numerous and

LIFE IN A HIMALAYAN VALLEY.

7 and 8. A boy and girl from Noranu village in the upper part of the Tons Valley.

Warm clothes are essential where the villages are under snow for nearly six months of the year.

The jewelry is much plainer than in Jaunsar-Bawar and consists chiefly of silver chains and rupee coins. The boy has a tooth pick and an ear pick hanging from his chain.

Photos by E. C. Mobbs.

big enough to carry all the jewelry must be a very painful proceeding. First small holes are made and these are gradually widened by placing in them small pieces of bamboo wood of increasing thickness. I have often seen little girls with ten or more little pieces of wood stuck through each ear in this way.

A woman's jewelry often represents all the family wealth, silver being the only form in which wealth is stored. As forest officer of the district I often had to employ the villagers for various works, and always had to pay their wages in silver, which meant bringing up periodically from the plains large quantities of silver rupees. Paper money is useless, since if carried by a villager it is liable to be spoilt at once by rain or perspiration. Also it is difficult for the people to store paper safely, whereas silver does not deteriorate, can easily be converted into jewelry if desired, is always saleable for coins again, or exchangeable for goods, and in general is much better understood by the illiterate people.

The men wear little jewelry, although in Jaunsar-Bawar they often have a small but heavy necklace of silver, or really half a necklace, since the silver is only in front of the neck, a piece of string sufficing for the back half. These necklaces frequently have a small crudely enamelled pendant in the centre, with one or more silver rupees on either side. In the Tehri-Garhwal area the men often have two small silver instruments hanging from a long silver chain or a fine cord placed round the neck. These will be seen in the photo of the boy of Noranu village, and they are a tooth-pick and an ear-pick respectively. Women also often have these two instruments attached to one of their necklaces, thus combining utility with ornament.

In a few villages in the upper part of the Tons Valley, the people have a peculiar custom of wearing at the back of the neck a piece of white porcelain like shell, tied in position with a piece of string. This is worn by men, women and children, and seems to form almost a part of their religion. The shell is obtained from traders of an adjoining state, and is said to come from a very great distance. The origin of the custom is unknown and I could obtain little satisfactory information about it, beyond that the shell was worn for good luck and for the sake of tradition.

(To be continued.)

CHANGA MANGA MULBERRY AND ENGLISH ASH.

BY C. G. TREVOR, PRESIDENT, F. R. I.

It is in the fashion to buy a tennis racket of English ash and the most expensive Indian made tennis rackets are made of this material because they can be sold at a higher price. For some time I have maintained that Changa Manga mulberry was just as good if not better, and in talking to various persons interested in the sports goods trade of Sialkot my opinion has never been contradicted. In order to obtain a definite opinion on this matter Messrs. Uberoi, Ltd., supplied the Forest Research Institute with samples of imported English ash, and the Divisional Forest Officer, Changa Manga, supplied a mulberry log. The report of Mr. Seaman, in charge of the Timber Testing Section, is reproduced below :—

(1) The moisture contents of the ash and the mulberry were almost identical though the ash was received here as seasoned material and the mulberry came as green logs in March. The conclusion is that before the end of the hot weather the two had reached a condition of equilibrium which was practically the same for both.

(2) The ash was about 19 per cent. heavier than mulberry.

(3) For practical purposes there was no difference in strength between the two species which means that for the material tested the mulberry possessed somewhat more strength *in proportion to its weight.*

(4) The mulberry in the average was consistently tougher (values under the heading of "work" in three different columns) than the ash.

In all cases the differences between the two species, however, were slight.

The results of these comparative tests are given below. Changa Manga mulberry can now be advertised as equal to, if not superior to, imported ash for tennis rackets, and there is no reason why this timber should not be sold under its own name instead of being called

Indian white wood which means nothing. The Punjab has the monopoly of this very valuable product, the demand for which exceeds the supply, and every possible effort should be made to extend its cultivation.

Forest Research Institute, Dehra Dun, U. P., India.

Species.	Consignment Number.	Locality.	Seasoning.	Specific Gravity.	Moisture Content %	Weight, lbs. per cu. ft.	Radial Shrinkage %	Tangential Shrinkage %	Static bending. Fibre Stress at Elastic Limit, lbs. per sq. in.	Static bending. Modulus of Rupture, lbs. per sq. in.	Static bending. Modulus of Elasticity 1,000 lbs. per sq. in.	Static bending. Work to Elastic Limit, in-lbs. per cu. in.	Impact bending. Fibre Stress at Elastic Limit, lbs. per sq. in.	Impact bending. Maximum Drop in inches.	Impact bending. Modulus of Elasticity 1,000 lbs. per sq. in.	Impact bending. Work to Elastic Limit, in-lbs. per cu. in.
Morus alba—(Mulberry)	.. 0—955	Changa Manga (Punjab)	A.D.	·614	9·6	42	..	..	9,485	17,450	1,310	3·92	35,335	17	2,532	27·62
Fraxinus excelsior—(English ash)	.. 0—958	Punjab	A.D.	·685	9·8	47	..	..	10,180	17,830	1,753	3·30	34,565	17	3,109	21·55

Species.	Consignment Number.	Locality.	Comp. Parallel to Grain. Fibre Stress at Elastic Limit, lbs. per sq. in.	Comp. Parallel to Grain. Maximum Crushing Strength, lbs. per sq. in.	Comp. Parallel to Grain. Modulus of Elasticity 1,000 lbs. per sq. in.	Compression Perp. to Grain, Fibre Stress at Elastic Limit, lbs. per sq. in.	Hardness. Radial, lbs. load.	Hardness. Tangential, lbs. load.	Hardness. End, lbs. load.	Shear. Radial, lbs. per sq. in.	Shear. Tangential, lbs. per sq. in.	R. A. Impact (C. notch). Work (foot-lbs.)	Remarks.
Morus alba—(Mulberry)	.. 0—955	Changa Manga Punjab.	4,445	7,460	1,490	1,720	1,555	1,620	1,650	2,580	2,915	12·8	
Fraxinus excelsior—(English ash)	.. 0—958	Punjab	5,590	7,795	2,206	1,850	1,420	1,715	1,575	2,320	2,475	11·0	

Legend :—
A. D. =Air Dry.
K. D. =Kiln Dry.
G. =Green.

Specific Gravity=Based on volume as tested, and weight oven dry.

Legend :—
Maximum Drop in inches =Maximum Drop (in inches) of a 50-lb. hammer causing complete failure.
Hardness =Load (in pounds) required to imbed a 0·44 inch ball to one-half its diameter.

PRECOCIOUS FLOWERING OF TREE SPECIES.

BY R. N. PARKER, C.C.F., PUNJAB.

Cases of abnormally early flowering have already been recorded in the *Indian Forester*. One was a seedling of *Dendrocalamus strictus*, the other a seedling of *Swietenia mahagoni*, In Kasauli, seed of *Ailanthus glandulosa* was sown in April. 1934, and on the 20th June one of the seedlings was found in flower. Its age from the time of germination was about two months and height of stem about 3 inches. The seedling has produced a solitary flower—one would hardly expect to find the normal panicle of this species on so small a plant.

Two cases of trees which habitually flower at an early age are known to me. One is a variety of *Melia azedarach* which flowers as a seedling and continues in flower or fruit for several years but apparently never grows to tree size. The other is a West Indian tree *Catalpa longissima*. This flowered in Dehra Dun at a height of 2 feet and flowered and fruited freely at a height of 5 feet. I have been told by others who have cultivated this tree that early flowering is usual with it.

THE BIOLOGICAL CONTROL OF TEAK DEFOLIATORS.

BY C. F. C. BEESON, FOREST ENTOMOLOGIST, F. R. I.

NOTE.—A limited number of reprints of this article is available. These may be obtained at a cost of -/8/- annas per copy, post free, on application to the Forest Entomologist, Forest Research Institute, Dehra Dun.

Foreword.—The results of research on the defoliation of teak obtained by the Forest Research Institute have been recorded from time to time in the *Indian Forester* and in the annual reports on Forest

Research in India*, as well as in official notes to the forest departments interested. The object of the research is the discovery of the essential factors in the biological control of teak defoliators.

Caterpillars defoliating a teak tree can be killed by spraying or dusting with stomach poisons, but this method can never be regarded as a practical measure until plantations can be reliably patrolled for the detection of incipient outbreaks, and spraying operations can be carried out with the celerity of a fire-fighting organisation, unhampered by sanctions and budget restrictions. Biological control demands intelligent planning and application; it may increase the establishment costs in some regions; in others it may be achieved with no special expenditure. One disadvantage is that it adds a small fraction to the unproductive areas within a forest reserve.

This article is written to provide an explanation of the theory of biological control. It is necessarily much condensed, and in places unavoidably technical, but the writer hopes that it will demonstrate which are the useful and which are the injurious factors, and how the defoliation of teak can be controlled by making use of numerous, apparently insignificant, natural remedies. The practical application of the theory involves the diagnosis in each locality of the missing or defective factors of natural control and the rectification of them. There is no single panacea that can be prescribed for universal adoption.

THE THEORY OF BIOLOGICAL CONTROL.

Generations and Population Densities.—The defoliation of teak in India is caused by two species of caterpillars, *Hyblæa puera* and *Hapalia machæralis*, which have a sequence of thirteen to fifteen generations a year in the south and eight to ten generations in the north, and also by a group of caterpillars, grasshoppers and beetles

*Forest insect pests in Burma, Ind. For., 1921, Aug., pp. 309—317.
Some types of teak defoliation, Ind. For., 1926, April, pp. 143—146.
The defoliation of teak, Ind. For., 1928, April, pp. 205—215.
Loss of increment in teak defoliation, Ind. For., 1931, pp. 543—545.
Identification of teak defoliators in the field, Ind. For., 1932, pp. 689—691.
Forest Research in India, 1924-25, pp. 95-96; 1925-26, pp. 115-116; 1926-27, p. 144; 1927-28, pp. 170-171; 1928-29, pp. 144-145; 1929-30 pp. 158-160; 1930-31, pp. 189-190; 1931-32 p. 59; 1932-33, pp. 29-30; 1933-34, pp. 27-35.

with longer life-cycles, that are of variable importance locally and seasonally. For the sake of simplicity this exposition of biological control is based on the two more important species.

A teak plantation affords an environment in which the populations of the two species of defoliators regularly fluctuate very considerably in density. Two factors of the environment are responsible for the periodic multiplication and destruction of the defoliator population, *viz.*, food-supply (teak foliage) and climate (temperature and rainfall). Oscillations in the population densities of the defoliators occur within the period of a year and the close of each annual period is marked by low densities. So long as the environment remains constant the average densities of the defoliators, as opposed to the amplitude of oscillations, remain unchanged. There is no progressive increase or decrease in the average density from year to year ; the populations are in a state of balance with the environment. The controlling factors producing this state of balance are the natural enemies of the defoliators—parasites, predators, and diseases. Control, which is practically a balanced control of this kind, could exist in a teak plantation during a short period of years in which no great change occurs in the composition of the stand. Although teak defoliators are *controlled* by their natural enemies it is not implied that they are controlled at densities at which no economic damage results. On the contrary, at the maxima of oscillations the damage done during one or two generations of the pests may be severe.

The problem of biological control by means of natural enemies is to restrict the amplitude of oscillations and to reduce the level of the average density. How may this be achieved by silvicultural measures ?

The Regeneration Area.—At the time of creation of a teak plantation the area to be regenerated is, according to common procedure, cleared entirely of all vegetation previously established on it, the clearance being completed by burning the unexploitable refuse. Burning varies in intensity from isolated bonfires to a conflagration that covers the whole area. This operation destroys at the same time the

whole complex of insect and small animal life that constitutes the agencies controlling the densities of the defoliators. Re-population of the devastated area by defoliators is possible as soon as their food supply is available, but re-population by their natural enemies is a slower process, and must always be subsequent to the establishment of defoliators. If the regenerated area is one of a series of annual coupes and immediately adjoins previous plantations, it is evident that the destruction of the sources of supply of natural enemies (and also of other insect associates which are equally important in biological control; see below) progresses far more rapidly than the creation of the food supply of defoliators. Re-population of the new teak crops by natural enemies is still further delayed.

The Silvicultural Remedy.—These undesirable effects can be nullified by modifications of the silvicultural operations. Regeneration areas of large extent can be sub-divided by strips or patches in which the pre-existing vegetation is retained, and from which fire is completely excluded. Silvicultural considerations should govern the choice and location of the fractions of the regeneration area to be perpetuated as reserves for the desired animal life. Ground unsuitable for teak is an obvious choice, but wherever a small stream or drainage line intersects the area, a strip of natural vegetation should be preserved along it. The boundaries of the regeneration area, instead of being pre-determined map-lines, should be chosen so that they leave zones of natural jungle between the new coupe and previously formed plantations. Where rivers or large streams occur their banks and riparian flora should be excluded from the planted area in a wide belt. The claims of potential I quality teak land near streams must be offset against the fact that teak is undesirable on the edges of streams owing to its early and profuse production of new foliage in exposed situations. For the same reason an avenue of evergreens, or species other than teak, is desirable along wide main roads and clearings, camps and depot sites, etc. Permanent agricultural land near or within plantation blocks is not an undesirable feature; its natural enemy communities released by the rotation of crops, disperse into adjoining forest.

The extent to which sub-division of a large clear felled coupe, by strips of "natural" mixed forest is practical is limited by the unit area that is necessary to obtain a satisfactory burn. It is suggested by Mr. Champion that the maximum size of a burnt block need not exceed 40 acres, no part of which should be more than 400 yards away from unburnt forest. The average minimum is perhaps 20 acres. The width of the excluded dividing strip should be just sufficient to ensure its protection from fire. The exclusion of isolated patches is possible only where the patch is in a particularly moist situation, or carries timber of species that might be retained as a sub-compartment. It is worth while making the preparations to protect isolated patches, as if they get burnt accidentally they will still have an appreciable though reduced initial value.

By means of these exclusions in the form of natural mixed forest together with those in the form of roads, rivers, unproductive land, etc., the area in a plantation working circle actually under teak may not exceed three-quarters of the whole. This quarter bearing no teak provides a dipersal region for swarming moths and increases the possible mortality before oviposition. There is theoretically little advantage in increasing this ratio (which in some plantation schemes, *e.g.*, Nilambur, is already exceeded). The advantage to be obtained from the non-teak bearing area lies in having as much as possible under undisturbed natural forest rather than in the form of blanks and failures on which the beneficial fauna has been exterminated.

Parasite and Predator Reserves.*—The retention of parasite and predator reserves provides nuclei from which the re-population of teak stands can start. The penetration and colonisation of the planted area can be accelerated and ensured by the creation of a favourable environment for these animals. The pure teak crop alone does not

* *Definitions :* A *parasite* is the grub of an insect that kills by feeding inside the body or attached to the outside of the body of a caterpillar. One parasite grub affects only one caterpillar. A *predator* is a hunting insect that catches its prey and devours it. Birds, lizards and spiders are also predators. One predator may kill many caterpillars. A *specific* parasite attacks only one species of caterpillar. A *polyphagous* parasite attacks several species of caterpillars. Insects parasitised or preyed on are termed *hosts.* A *life-cycle* (or generation) implies a period elapsing from the deposition of an egg to the appearance of the moth.

provide the required environment. A mixture, simply because it is defined silviculturally as a mixture, does not necessarily provide it. The association of one or a few timber species with teak in the overwood is of negligible value in producing an environment suitable for natural enemies, though it may reduce the population density of defoliators on the area concerned. What is required is a varied flora with its mixed insect communities and dependent groups of polyphagous predators and parasites.

Leaving for the moment a consideration of the specific parasites of defoliators, which may be regarded as factors primarily dependent on the existence of defoliators, the need for polyphagous enemies may be explained.

Polyphagous Parasites.—General or polyphagous parasites can control their hosts at higher densities than specific parasites can. This results from interaction effects when more than two species are involved. Interspecific oscillation is reduced in violence and its amplitude decreases with time in the more complex types of interaction. It would be necessary to resort to a mathematical presentation of the case in order to explain it clearly. When the pest is a species like either of the teak defoliators, which fluctuates violently in numbers and becomes very rare periodically owing to the action of external factors (food supply, climate, etc.) polyphagous parasites form the most effective control. They maintain their numbers by breeding on alternate hosts and are available at a higher density when the population of the pest again begins to rise. In this characteristic they are more valuable than specific parasites.

Polyphagous Predators.—In contrast to parasites, polyphagous predators do not produce offspring in proportion to the number of prey destroyed, and their densities are less dependent on variations in the density of any one of the species constituting their prey. Predators deliver an increased severity of attack in the same generation in which an increase in the density of the prey takes place ; moreover juvenile predators begin to destroy prey shortly after they are born, and compared with parasites, their length of life is very much greater.

It is an interesting paradox that although predators are destroyed by other primary predators, or by their own kind (cannibalism), this destruction actually permits more predators to survive when prey are scarce than would otherwise be possible. Consequently predators and their prey tend to be maintained at their steady densities, for increasing oscillation is unlikely as a result of their interaction.

Silvicultural Measures.—The mixed flora that forms the desired environment for the beneficial micro-fauna can be obtained by artificial introduction or by selection and conservation of natural growth.

Underwood.—Artificial introduction may, for various reasons, be presumed to be restricted in practice to such species and operations as are required to establish an underwood. A pure underwood might be subject to extensive defoliation, but it would not necessarily present the same undesirable features as a pure overwood, since it would maintain a higher density of predators. But most of the species tried or suggested for underplanting teak are of neutral value in this respect as they support a very limited series of defoliators and sap-suckers. There are a few exceptions but none of their defoliators are alternate hosts of parasites of teak pests. A mixed underwood of species with different growth characteristics, including evergreens, is ideal. An important function of the underwood is entirely mechanical in that it offers an obstacle to the movement of ovipositing moths and migrating caterpillars. The more stems there are on the area and the more intricate the barrier of foliage between the ground and the teak canopy, the greater the mortality of caterpillars migrating from one teak tree to another.

Soil Cover and Undergrowth.—A soil cover can be preserved from the very start of a direct plantation by exclusion from the early weedings and cleanings of all annuals, coppice shoots, natural seedlings of trees and shrubby growth that do not interfere with teak plants. Coppice shoots, in particular, are valuable in avoiding a complete break in the continuity of the generations of local defoliators. Coppice shoots of teak stumps, on the other hand, and advance growth of teak are undesirable at any stage in the rotation of a teak plantation.

In *taungya* plantations the crops introduce a limited insect community which includes polyphagous elements that persist after cultivation ceases. The effect of the *taungya* crop could be made more valuable by retaining tree coppice.

Plants for the undergrowth or understorey which are useful in small proportions are :—

Adina cordifolia, Bamboos, *Boerhaavia diffusa*, *Careya arborea*, *Cassia fistula*, *Cyclea peltata*, *Dalbergia latifolia*, *Desmodium gangeticum*, *Diospyros cordifolia*, *D. montana*, and *Diospyros* spp., *Grewia hainesiana*, *G. tiliaefolia* and *Grewia* spp., *Helicteres isora*, *Hydnocarpus wightiana*, *Kydia calycina*, *Lagerstroemia parviflora* and *Lagerstroemia* spp., *Ricinus communis*, *Schleichera trijuga*, *Tabernœmontana heyneana*, *Tiliacora acuminata*, *Tragia* spp., *Terminalia tomentosa*, *Uraria lagopoides*, *Wrightia tinctoria*, but further investigation will modify this list. Species that should be eliminated from the underwood, undergrowth and everywhere in the vicinity of plantations are those serving as alternate food-plants of teak insects, *i.e.*, *Callicarpa* spp., *Premna latifolia* and *Vitex negundo*. Grass is as undesirable in biological control as for other reasons. Lantana does not support teak defoliators, nor does it provide useful insect life or any special entomological advantage to commend its use as a cover crop.

The preservation of the indigenous vegetation in patches or wedges within the coupes and in belts between the coupes, as advocated above, will ensure the earlier colonisation of the planted areas by natural seed dispersal ; and the timely introduction or appearance of an underwood will prevent excessive development of species like *Calycopteris floribunda*, *Glycosmis pentaphylla*, *Helicteres isora*, and Lantana.

In localities where in-seeding and re-growth are so profuse that the chief concern of the territorial officer is the suppression of rampant climbers and dangerous weeds, the strips and peripheral zones of natural forest may appear superfluous, but it is better to strive for weed extermination by more efficient burning on the coupe than by reducing the amount of unburned forest.

Supplementary Measures.—The hypothesis outlined so far indicates the measures that the forest officer can adopt to initiate and maintain a proper regulation of the densities of defoliators through the agency of those of their natural enemies already inhabiting the region. The more numerous the controlling factors and the more complex the interaction the greater is the possibility that the densities of the pests will remain at their steady seasonal values. The question that now remains to be discussed is whether the average density established by these measures is acceptable. If it is close to that at which economic damage is caused it may be tolerable ; if much higher, additional measures are needed. The supplementary measures in the biological control of teak defoliators include the introduction of species of parasites and predators that are not already established in the affected locality.

Distribution of Natural Enemies.—In this connection a survey of the natural distribution of parasites and predators of teak insects and their associates is being made by the Forest Entomologist and it is already evident that their distribution throughout India and Burma is far from uniform. The following table summarises the regional occurrence—species being indicated by index numbers.

Region.	*Parasites of Hyblaea puera.*	*Total species per region.*
North-western ..	1, 4, 5, **8**, 10, 12, **16**, 18, 21 ..	9
Central ..	3, 11, **15**, **16**, **17** ..	5
Southern ..	9, 13, **16**, 19, 20, 21, **22** ..	7
Eastern ..	2, 6, 7, **8**, 14, **16**, **17**, 18 ..	8
	Parasites of Hapalia machaeralis.	
North-western ..	**8**, **16**, 22, 24, 26, 28, 29, 30, 31, 36, 37, 41, 42, 49, 51, 52, 60 ..	17
Central ..	**15**, **16**, **17**, 24, 25, 27, 29, 32, 34, 35, 38, 39, 40, 41, 43, 44, 45, 46, 48, 49, 50, 53, 54, 55, 58 ..	25
Southern ..	**16**, **22**, 23, 29, 31, 32, 33, 41, 47, 48, 56, 57 ..	11
Eastern ..	**8**, **16**, **17**, 24, 29, 30, 31, 41, 49, 50, 57, 58, 59 ..	13

The north-western region centres on Dehra Dun ; the central region is represented by Hoshangabad division, Central Provinces ; the southern region by the Nilambur plantations, Madras, and South Coorg ; the eastern region comprises records from Bengal, Burma and the Malay Peninsula.

Hyblaea puera has 22 species of parasites and *Hapalia machaeralis* has 43 species, of which five species are common to both (indicated in the table by different type, numbers 8, 15, 16, 17 and 22). It will be seen from the table that the distribution of the 60 species of parasites, according to present records, is very irregular.

A similar survey of predators is in progress.

Introduction of Natural Enemies.—In localities where there is a poverty of natural enemies the introduction of selected species of proved efficiency can produce beneficial results. But it is improbable that introduced species will become permanently established, except in very special cases, unless a suitable environment exists. For this reason the encouragement of a varied flora in teak plantations has been emphasised as an essential preliminary to the achievement of an effective parasite and predator sequence, and is one of the first remedial measures that should receive attention. The introduction and colonisation of new natural enemies is not an operation that the forest staff can undertake unaided; the co-operation of the Forest Research Institute is a necessity. It is an exceedingly complicated problem, for the addition of a new species to the existing association of competing species sets up new reactions, and these may or may not be advantageous in their effect on the density of the pest. In choosing a species for introduction its efficiency is not to be judged by the fraction of pests it destroys; it is necessary to discover how readily it is influenced by changes in the density of the pest.

A study of the enemy association in a locality where control is satisfactory yields clues which indicate how gaps in the series should be filled in a locality where control is deficient. Polyphagous parasites are most effective where their alternate hosts occur, otherwise they behave like specific parasites. Specific parasites control their hosts at low densities, provided their life-cycles conform closely with those of their hosts, but they tend to produce oscillations by which the host population is broken up into widely separated small groups of individuals which are nuclei of subsequent increase. As the densities of teak defoliators are subject to violent seasonal fluctuations, specific parasites alone are unlikely to maintain effective economic control.

More reliance should be placed on the predators of teak pests which have annual life-cycles or periods of activity adjusted to the seasons and in consequence can form the reserve force that is an essential auxiliary of parasite action.

To secure the desired control the safest plan seems to be to introduce for a particular object one species at a time, whose habits have been well studied, and to observe its progress and the effect exerted on the density of the host when it is abundantly colonised. Additional species can be brought in later with a definite knowledge of the situation. Among the parasites the first species to receive attention should be the five common to *puera* and *machaeralis*. Among the predators the first kinds to be colonized are mantids, carabids and reduviids.

Fire.—By destroying the soil cover and the beneficial animals fire is a harmful factor in biological control. In Nilambur, 2,600 acres out of 4,500 acres planted with teak were burnt in March and April : this was followed by " as complete a defoliation by caterpillars as I ever remember to have seen," (to quote a competent judge).

Owing to the high number of generations completed each year by teak defoliators an estimate of the results of liberation of new parasites can be made relatively quickly and such measures therefore fall well within the limits of a practical policy. But a methodical record of the frequency and intensity of defoliation is a necessity not only for the proper evaluation of results but at all times. Personal opinions on these points are no more reliable than subjective opinions on changes in the weather.

Summary of Control Measures.—Summarising, we arrive back at generalisations already familiar to foresters, *viz* : (*i*) sub-division of large blocks of pure teak (but sub-division by means of pre-existing forest rather than of newly created stands or of mixtures) ; (*ii*) establishment of a varied flora under the teak canopy (but at the outset by retention of coppice re-growth and miscellaneous seedlings rather than by artificial introduction of selected species at a later stage) ; (*iii*) elimination of harmful plants (but inclusion in this category of alternate food-plants of defoliators) ; (*iv*) maintenance

of an understorey in older stands (but with regard to its value as a shelter for beneficial animals and as obstacle to defoliators) ; (*v*) introduction of parasites and predators (but after careful assessment of the defective factors of the locality).

Expected Benefits.—When all the agencies of biological control are working effectively defoliation will be restricted to a light grade of skeletonisation, perforation or ragging, with occasional foci of high population density that do not spread but disappear in one or two weeks. Widespread epidemics will not occur. It will need extremely abnormal weather conditions to upset the balance of control and cause an epidemic.

Biological control is working effectively in many teak plantations at the present time, and these plantations suffer only from epidemics that start elsewhere. When losses in increment and other dangers of defoliation have been correctly assessed it may very probably be concluded that epidemic defoliation is the only grade of economic importance and the only hazard requiring preventive measures.

A TEST OF THE PRECISION OF THE STANDARD INDIAN SAMPLE PLOT METHODS.

BY H. G. CHAMPION, SILVICULTURIST, F.R.I.

Although a good deal of misconception is prevalent as to the real purpose and value of the many crop increment sample plots maintained throughout our forests by the Research divisions, at least so much is generally known that by periodic callipering, supplemented by the felling and detailed measurement of a few sample trees, the research officer aims at determining the volume increment laid down by the trees in the plot. Further, among the better informed, it is also known that the methods followed for determining the increment of the plot from sample tree measurements were developed from the procedure arrived at by that outstanding German forester, Dr. Adam Schwappach. Finally, our research officers all know the points in which we have departed from Schwappach's procedure and the reasons for such amendments, but unless the writer is mistaken not many of them would like to state how close to the true crop volumes and

increments their measurements work out, on the average or in the individual case.

In order to collect information on this point, it is the practice to measure up all the trees in a plot when for any reason it is found desirable or possible to clear fell it. Obviously, only reasonably normal plots are of any use for the purpose and chances do not often occur. A few years ago, however, an opportunity arose in Buxa division in Bengal when two sal plots were to be closed as all the surrounding forest was to be clear felled.

The Research Officer first selected a set of sample trees in the usual way except that as the plot was to be clear felled he was able to take trees the removal of which would have caused gaps in the canopy. He chose however only the minimum number accepted, six, in place of the eight to ten ordinarily taken whenever possible. All trees in the plot were then felled and each was measured up fully as though it were a sample tree. The measurements were sent to the Research Institute for computation of crop volume, which was done in three ways :—

(*i*) The standard procedure was followed, drawing height and form factor curves through the points given by the six selected sample trees.

(*ii*) The same method was followed, but the points supplied by all the trees were used for drawing the curves.

(*iii*) The volume of each tree was calculated separately and the volumes totalled giving the volume by direct measuresment.

The three results were compared and the reasons for such differences as occurred were sought. Some of these differences could easily be ascribed to details of mathematical procedure such as rounding off, and are unimportant since when the plot data are used for compiling yield tables, they will cancel out. The remainder are ascribable either to faulty curve drawing through the points provided by the sample trees,—which is remediable to some extent—or to the selection of insufficiently representative sample trees.

In this example, it eventuated that the volumes of stem timber calculated from the six sample trees were 5 % too high and 1 % too high, respectively, in the two plots. Of the 5 %, 1 % was fortuitous and 4% had to be ascribed to the selection of sample trees. The agreement for smallwood (from 8″ down to 2″ diameter over bark)

was as expected less close, and in fact, for one plot was very great, (for the two plots, the differences from the directly determined values were 47% and 6%). The reason for this unexpectedly high deviation was at once apparent when the smallwood figures of the six sample trees were compared with those of the rest of the trees. Somehow or other, no less than four of the six trees have smallwood volumes *so conspicuously lower than the other trees* of similar diameter (even only one quarter to two-fifths of the average figure) that it is difficult to ascribe their inclusion to mere coincidence. Something must have gone wrong with the measuring or recording of these trees. The discrepancy is actually all in the branch smallwood and so is of no importance in any case, and more than this, on our latest procedure, we no longer measure branch smallwood in each tree but utilise average values derived from the large number of such measurements which have accumulated as a result of 20 years of sample plot work.

It must be mentioned that the precision attained in determining standing crop volume as in the above example, and precision in crop increment as the difference of two successive measurements, are very different matters. Thus if we found our volume measurements were liable to vary 5% either way from the true value, in any given example, it might happen that the error would be *minus* for the first and *plus* for the second measurement. An increment of 10% of the average volume would then be recorded even if the crop had not grown at all, and 10% in any case is more than most plots put on in the usual 5-year interval. It is clear that volume increment obtained as the difference of two measurements on the sample tree method at a 5 or even 10-year period is liable to be very misleading, though rapid and uniform growth may render good values obtainable under special conditions. Basal area increment is of course a different matter, though here also big errors are by no means impossible.

The examples referred to in this note are not the only Indian ones we have, but as attention has just been directed to them, it was thought that it might be of interest to a wider circle than would ordinarily hear of it. A tabulated comparison is appended for those who like figures.

COMPARISON OF CROP FIGURES BY THE FORM FACTOR HEIGHT CURVE METHOD, WITH THOSE BY DIRECT MEASUREMENTS AFTER CLEAR FELLING.

Shorea robusta in Sample Plots 1 and 2, Buxa division.

Sample Rot No.	Average height.	Form factor. Stem timber.	Form factor. Stem small-wood.	Form factor. Total small-wood.	Average diameter.	Basal area per acre.	Volume per acre. Stem timber.	Volume per acre. Stem small-wood.	Volume per acre. Branch small-wood.	Volume per acre. Total.	Remarks.
	Feet.				Inches.	sq. ft.	c.ft.	c.ft.	c.ft.	c.ft.	
1	(1) 81	·237	·127	·182	12·1	110·57 −0·7%*	2,119 −1·0%	1,133 −14·7%	494 5·7%	3,746 −4·3%	* Due to grouping.
	(2) 80	·233	·111	·164	..	..	2,064 1·6%	979 −1·2%	471 10·8%	3,514 2·0%	
	(3) 80	·239	·110	·169	..	109·8	2,097	967	522	3,586	
2	(1) 88	·324	·029	·075	16·6	84·01 −1·4%	2,392 −4·7%	211 8·5%	343† 46·9%	2,946 2·3%	†The branch smallwood of sample trees 37, 14, 10 and 23 is surprisingly less than that of other trees of the same diameter.
	(2) 88	·316	·029	·099	..	..	2,339 —2·5%	216 6·0%	518 —2·7%	3,073 −2·7%	
	(3) 86	·320	·032	·103	..	82·8	2,280	229	504	3,013	

The % figures are the differences from (3).
(1) Standard procedure (From Form Factor Height curve method) using a normal selection of 6 sample trees.
(2) Standard procedure (From Form Factor Height curve method) using all trees in the plot as sample trees.
(3) Felled tree measurements direct, deriving averages in the same way as (1) and (2).

POISONED WATERS.

BY J. W. NICHOLSON, DEPUTY CONSERVATOR OF FORESTS.

When I first came out to India I was posted to a district which had a somewhat unenviable reputation for blackwater fever and severe forms of malaria. No one appeared to know how one contracted blackwater but it was perfectly evident that there were certain well-defined localities where one was more likely to contract severe forms of malaria. The popular opinion was that water had something to do with it. As time passed and as other areas in the province with an unhealthy reputation came under my observation I noticed that the worst areas were nearly always at the bottom of hills or close to the sources of springs; that usually the worst areas were in sal forests, which follow typically certain ferruginous rocks specially high level laterite in Bihar and Orissa; that severe forms of malaria were liable to develop whatever the season of the year and whether there were mosquitoes or not; and that the persons most liable to contract severe forms of malaria were those who had to encamp for lengthy periods continuously in the same unhealthy locality, *i.e.*, to remain for one period of 10 days was more dangerous than to remain for two periods of 5 days. Putting two and two together it seemed to me that ruling out water as a source of malaria the only theory which seemed to fit the facts of the distribution of bad forms of malaria was that the water of certain localities had a stimulating effect on the malarial parasite if it was already present in the blood.

More time passed and I was deputed to East Africa. Here the same state of things was noticed in respect of the distribution of blackwater and cerebral malaria both of which were fairly local, certain areas having a more sinister reputation than others. Further, a striking point was that the malarial epidemics were worst in seasons of drought, which is of course just when mineral salts, beneficial or poisonous, would be most concentrated. Hitherto when I had propounded my water theory to any doctor I had usually been looked at with pity as an ignoramus who did not know that malaria was not a water borne disease. A well-known practitioner in East Africa who

agreed that there might be a great deal in the theory proved to be an exception. He stated that no one had properly studied the chemistry of the blood in blackwater cases and that he, empirically, had discovered that the salt of a certain mineral had very bad effects on blackwater patients. What that salt was I will not attempt to reveal as my memory is not absolutely reliable although I am moderately certain of the element concerned.

On return from East Africa I was posted to Palamau division in which the plateau of Netarhat is situated, at one time proposed as the site for a provincial hot weather station. The climate of Netarhat is delightful but it has been acquiring a bad name for malaria. The latter occurs, as in most places in India, at the end of the rains and beginning of the cold weather when, apart from the greater prevalence of mosquitos, climatic changes induce malaria to appear, but the worst forms of malaria occur in the hot weather. In the hot weather of 1931 as a result of the serious illness of a high official a thorough medical investigation was carried out. As a result of this not a single infected mosquito was detected. I am personally not a malarial subject but in each of the hot weathers of 1931-32 and 1933 I have found that after about a week's stay at Netarhat I have had to take large quantitites of quinine or plasmoquine as a preventive against malaria and I have not always been successful. At other times of the year I have had no trouble in this respect. The water at Netarhat comes from a well situated near the source of a spring on high level laterite and no amount of chlorinating has led to any improvement in the health of visitors.

This year as I was due to visit Netarhat with my wife and small child I decided to put my theory to a practical test and we obtained all our drinking water from a river in the plains 4 miles away. During a stay of 12 days we kept in perfect health. Dentition troubles then broke up our party. I moved camp to another place on a continuation of the same plateau where the local water was similar to that at Netarhat. After a week's drinking of this water I had to start choking off incipient malaria and I came to the welcome conclusion that the only safe water to drink was " UISGEBEATHA "—" the water of life."

I have quoted from my own personal experiences but I could also have done so from those of others. A Settlement Officer, for instance, told me that in a certain unhealthy tract the only subordinate who kept fit was one who went to the trouble of having his water brought from his own distant village where the vintage was good. Medical authorities may regard my theory as rubbish but nothing will convince me that the average Indian is not right in connecting the healthiness of a place with its water and I feel that since the discovery of the life history of the malarial parasite insufficient attention has been paid to the causes of the stimulation of parasitical activity.

What is wanted is a comparative analysis of waters from unhealthy malarial tracts coupled with observations of the effects of the predominant salts on the activities of malarial parasites. If other forest officers have had similar experiences perhaps the medical authorities could be aroused to action.

STUDIES IN SPIKE DISEASE OF SANDAL

METHODS OF INOCULATION AND VARIATION OF RESULTS UNDER DIFFERENT METHODS

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Introduction.—The spike disease of sandal was first studied by Barber (3) and Butler (4) in 1903. Both recognised that the disease was infectious, but did not succeed in transmitting it experimentally. They suspected that the disease might be transmitted through haustorial connections. Butler (4) grafted 151 healthy sandal with diseased buds in Hosurmarigudi Plantation in Hunsur Range but none of the buds formed connection and sprouted or communicated the disease, apparently due to some mistake in the technique of budding. Coleman (5) was the first to succeed in transmitting the disease by grafting and also established definitely that the disease is

communicated only when there is an organic union between the diseased tissues of the graft and the healthy ones of the stock. He also proved experimentally(6) that the disease was transmitted through haustoria. The different methods of inoculations employed by subsequent investigators (10) and by us, has the same fundamental principle of securing an organic fusion of the diseased tissue with that of a healthy stock. All attempts at transmitting the spike disease by mechanical methods other than grafting of infected tissues, have been total failures. There are many other diseases among the virus group such as Peach Yellows, Leaf-Roll, and Aster Yellows where grafting or budding is the only known method of mechanical transmission. In fact there is a considerable variation in the degree of infectivity between different virus diseases; while in tobacco mosaic (1) mere contact of a healthy and diseased leaf is sufficient to transmit the disease, in curly top of beets (9) the disease is only transmitted with difficulty by sap injection methods, whereas in others like Peach Yellows (11) and Leaf-Roll (8) organic connection between diseased and healthy tissues is absolutely necessary to experimentally transfer the disease.

Methods of inoculation in spike disease of sandal.

The following are the methods of inoculation employed for transmitting spike disease :—

(1) *Twig-grafts.*—This consists in grafting diseased twigs on healthy plants, and pollarding of the plants is necessary to induce the grafts to sprout. Pollarding can be avoided by inarching, that is, healthy and spiked plants are brought close to each other and their branchlets grafted together. The diseased scion is severed from the mother plant in about 2 months, by which time the branchlets will have fused together.

Budding.—A piece of bark, $\frac{1}{4}$ to $\frac{1}{2}$ inch square, containing a dormant bud is removed from the branch or stem of the plant to be inoculated and substituted with a patch of bark of exactly the same dimensions, containing a dormant bud cut out of an infected branch and bandaged so as to leave the bud free to grow out. The plant as in twig-grafting has to be pollarded to induce the grafted bud to grow.

Patch bark-graft.—This is similar to budding but it is not necessary that the bark-graft should contain any dormant bud and the whole graft is fully bandaged over. The plant is not pollarded.

Ring bark-graft.—The twigs of the tree to be inoculated, are ringed by removing the bark all round to a width of $\frac{3}{4}$ to 1 inch and substituted with the bark of an infected twig of corresponding dimensions and bandaged. The plant is left unpollarded.

Leaf-insertion.—This method of inoculation was evolved by Sreenivasaiya (10) and consists in opening out a flap of bark of the branch or stem to be inoculated and introducing a spiked leaf cut to a rectangular shape between the bark and the woody cylinder and bandaging it. The plant has to be pollarded. He has not explained how the leaf inserted can live and transmit the disease. In our experiments we have found that unless the cut end of the midrib of the leaf is placed in close contact with the cut portion of the bark, the leaf inserted neither survives nor transmits the disease. This inoculation succeeds only when the cut midrib of the leaf forms organic connection with the tissues of the cut bark. The leaf remains green and alive for 1 to 3 months and shows an appreciable thickening.

Variation of results under different methods of inoculation :—The following statement gives the percentage of success in the different methods of inoculation conducted on sandal saplings 2 to 4 years old in pots and in beds :—

Kind of inoculation.	No. of plants operated.	No. in which grafts formed organic connection.	No. of plants which developed spike.	Percentage of successful transmission among plants where grafts formed organic connection.
Twig-grafts ..	100	29	29	100%
Budding ..	273	192	121	63%
Ring bark-grafts ..	324	189	77	41%
Patch bark-grafts ..	106	86	16	18%
Leaf-insertions ..	63	36	6	17%

Twig-grafts.—The twig-grafts contain a considerably larger quantity of infective material than the other kinds of grafts noted above, and never fail to transmit the disease. In addition to the saplings noted in the above table, we have inoculated large numbers of well-grown trees in the field with twig-grafts with similar results, and so far no case has been found in which the twig-graft forming organic connection. has failed to transmit the disease. In our experiments. twig-grafting is the crucial test. applied to sandal plants, which are suspected to possess immunity from the disease.

Budding.—Next to twig-grafts, budding has given the largest percentage of success. Both in budding and in twig-grafting, the plant has to be pollarded. that is, all the leaf-bearing twigs are cut out to force the growth from the grafts. In some cases if the grafts do not sprout readily, new shoots that appear on the stock have to be continuously removed till those from the grafts are forced out. This operation apparently lowers the vitality of the plant, and the resistence it can offer to the disease which may account for the larger precentage of success. In addition the active growth of inoculated material may help the rapid multiplication of the virus. It is proposed to consider the inoculations by budding in some detail, as it brings out some interesting aspects of the spike disease.

The following gives the details of one of the several sets of experiments conducted in transmitting the disease by budding. Each plant noted below was grafted with two buds of the Rosette type taken from fully spiked twigs.

Serial No.	Age of sapling at the time of inoculation.	Date of inoculation.	Dates on which buds sprouted.	No. of buds which sprouted out of two spiked buds grafted.	If healthy at first, the date on which spike appeared on bud shoot.	Date on which spike appeared on stock and the period of incubation.	Period of survival after inoculation.
	(a) Plants which produced healthy shoots from buds inserted and in which the disease did not appear.						
1	16 months	30-5-29	25-6-29, 28-7-29	Two	..	..	..
2	18 months	Do.	30-7-29	One	..	..	..
3	Do.	Do.	15-6-29, 5-7-29	Two	..	..	..
4	Do.	12-6-29	1-9-29	One	..	..	..
5	20 months	18-6-29	10-8-29	Do.	..	..	..
6	Sapling naturally grown in office compound.	11-5-29	6-6-29	Do.	..	..	..
7	Do.	20-5-29	10-7-29	Do.	..	..	..
	(b) Plants which first produced apparently healthy shoots from buds inserted on which spike developed subsequently.						
8	18 months	2-6-29	2-7-29, 8-8-29	Two	1st week of Aug. '29	End of Oct. '29 (5 months).	20 months.
9	18 months	4-6-29	20-7-29, 13-8-29	Two	End of Aug. '29.	Middle of Sept. '29 (3½ months.)	14 months.
10	Do.	12-6-29	24-7-29, 12-8-29	Do.	1st week of Sept.'29	2nd week of Oct.'29 (4 months.)	13½ months.
11	20 months	22-7-29	2-9-29, 12-10-29	Do.	2nd week of Oct. '29	2nd week of Oct.'29 (3½ months.)	12 months.
12	20 months	22-7-29	2-9-29, 13-9-29	Buds sprouted, one developed spike.	3rd week of Oct. '29	1st week of Nov.'29 (3 months.)	9½ months.
13	Do.	Do.	2-9-29, 3-9-29	Do.	2nd week of Oct. '29	2ndweekofMarch '30 (7½ months.)	13 months.

Serial No.	Age of sapling at the time of inoculation.	Date of inoculation.	Dates on which buds sprouted.	No. of buds which sprouted out of two spiked buds grafted.	If healthy at first, the date on which spike appeared on bud shoot.	Date on which spike appeared on stock and the period of incubation.	Period of survival after inoculation.
14	20 months	22-7-29	2-9-29, 11-9-29	Do.	4th week of Oct.'29	2nd week of Nov.'29 (3½ months.)	9½ months.
15	Sapling naturally grown in office compound	31-5-29	7-7-29, 7-7-29	Do.	1st week of Aug.'29	4th week of Aug. '29 (3 months.)	Damaged.
16	Do.	Do.	16-6-29	One	1st week of Aug.'29	2nd week of Aug.'29 (2¼ months.)	11½ months.
17	18 months	12-6-29	24-7-29, 12-8-29	Two	1st week of Aug.'29	2nd week of Oct.'29 (4 months.)	13½ months.

(c) *Plants which produced spiked shoots at the outset from buds inserted.*

Serial No.	Age of sapling at the time of inoculation.	Date of inoculation.	Dates on which buds sprouted.	No. of buds which sprouted out of two spiked buds grafted.	If healthy at first, the date on which spike appeared on bud shoot.	Date on which spike appeared on stock and the period of incubation.	Period of survival after inoculation.
18	16 months	2-6-29	6-7-29, 31-7-29	Two	..	2nd week of Sept.'29 (3⅓ months.)	13 months.
19	18 months	4-6-29	6-7-29, 28-7-29	Two	..	1st week of Sept. '29 (3½ months.)	16 months.
20	18 months	12-6-29	27-7-29	One	..	4th week of Sept.'29 (3½ months.)	10½ months.
21	Sapling naturally grown in office compound.	20-5-29	16-6-29	Do.	..	2nd week of Sept.'29 (4 months.)	10 months.
22	Small tree in office compound	11-5-29	6-6-29	Do.	..	2nd week of Dec. '29 (7 months.)	(23 months) only the budded branch had been pollarded
23	Sapling in office compound.	13-5-29	20-6-29	Do.	..	1st week of Aug. '29 (3 months.)	12 months.
24	Do.	Do.	Do.	Do.	..	2nd week of Aug. '29 (3 months.)	10½ months.
25	Do.	31-5-29	16-6-29	Do.	..	3rd week of Aug. '29 (3 months.)	9½ months.
26	Do.	Do.	7-7-29	Both buds sprouted, one was spiked.	..	4th week of Aug. '29 (3 months.)	10 months.

From the previous statement it can be seen that the results fall under three categories, namely (1) those in which the buds inserted developed only healthy shoots, (2) those in which the buds inserted produced apparently healthy shoots which subsequently became spiked, and (3) those in which buds produced spiked leaves to start with. We have under observation several plants falling under the first group which are growing quite healthy 5 years after inoculation, and many of them were pollarded repeatedly to ascertain if the disease was masked in them, but all of them sent out only healthy shoots. The plants in this group cannot be considered as being immune to the disease, as spike can usually be communicated to them by reinoculation. In many cases buds taken from the same infected twig and grafted on different plants have produced healthy shoots on some and spiked shoots on others.

This may be due to either or both of the following reasons:—

(1) Unequal distribution of the virus in different parts of an infected twig and its probable absence in some.

(2) Requirement of a minimum quantity of virus to transmit the disease, and the probable variation of this minimum for different individual plants.

In cases where buds inserted produce healthy shoots in the beginning and develop spike subequently, the rate of growth in the beginning is poor in some cases, but vigorous in others and the diseased leaves usually appear after one to two months of normal growth of the shoots. But in cases where the spiked shoots appear from the buds in the beginning alone the rate of growth is always very poor. The average incubation period, that is the time taken between inoculation and the appearance of the disease on the stock of the plant inoculated, is 3 to 4 months both for twig-grafts and buds. In our experiments we have come across a solitary case in which the disease appeared earlier on the stock than on the grafted scion. The stock pertained to one of the rare varieties of sandal (12) in which the hard endocarp of the seed is replaced by a papery coat.

In this case the diseased bud inserted grew quite healthy and vigorous for three months, and the disease appeared on the stock below the bud 20 days earlier than on the shoot from the bud. This variety

of sandal is probably very susceptible to the disease and the virus might have multiplied more quickly in the stock than in the grafted bud.

Patch bark-grafts and ring bark-grafts.—As already stated the the quantity of infected material used is the same both in budding and in patch bark-grafts, but there is a conspicuous difference, in the transmission of the disease between the two methods of inoculation. While in budding the percentage of transmissions reaches 63, in patch bark-grafts it is only 18. This difference may be due, partly to the active growth of the inoculated material and the consequent rapid multiplication of the virus, and partly to the severe pollarding involved in the operation of budding as pollarding of plants appears to diminish their power of resistance to the disease. If the plants are similarly pollarded after inoculations with patch bark-grafts, the percentage of transmissions in them is considerably enhanced.

The results of inoculations of patch bark-grafts and ring bark-grafts are comparable, as the plants are left unpollarded and the nature of material used is similar in both cases. The quantity of infected material grafted is two to three times more in ring bark-grafts than in patch bark-grafts and the percentage of disease transmissions is 41 and 18 respectively which nearly corresponds to the quantity of infective material used in the two operations.

The minimum incubation period in inoculations with these grafts is 3 to 4 months, and in such cases, a spiked adventitious shoot develops on the stock in the region just below the graft. When such shoots do not develop, the incubation period is very long, longer than in inoculations under other methods and may extend to a year.

Leaf-insertion.—In our experiments this method of inoculation has given a low percentage of success which is nearly the same as in patch bark-grafts. Unlike other methods of inoculation, where the grafts introduced get permanently fused with the stock, the leaf insertions live only a short time varying from 1 to 3 months, and successful transmission of the disease partly depends on the period the leaf introduced survives. This additional time factor involves complications in gauging results, and hence this method of inoculation is unsuited for any comparative study.

Seasonal variations in disease transmission.—An attempt was made to ascertain if the transmission of the disease was affected by the different seasons of the year, by conducting monthly inoculations in the first week of twelve consecutive months. As already stated twig-grafts which contain a large quantity of infective material, always transmit the disease whenever organic connection is formed with the stock, and hence seasonal factors have no effect on this method of inoculation. Among the other methods, in which a certain percentage of fusions fails to transmit the disease, bud-grafts were considered unsuited to the experiment, as it involves drastic pruning of the crowns of plants inoculated. It is obvious that the effect on plants of such pollarding is not the same in different seasons of the year. In the height of the growing season, this operation will considerably affect the vitality of the plant and may reduce its inherent powers of resistance, while during the period of rest, the deleterious effect will be comparatively little. Similarly the leaf insertion method was considered unsuited to this experiment as it is useless for any comparative study, for reasons noted in the previous para. Of the two remaining methods, patch bark-grafts and ring bark-grafts in both of which no pruning is necessary, the latter was selected for the experiment, as being more reliable.

Twenty-five to thirty sandal saplings two to three years old grown in separate beds were ring-grafted each month. Each sapling was inoculated with one graft. On an average 50 to 60 per cent. of these grafts formed organic connections. The percentage of disease transmissions among these fusions is noted below—

Month.	Percentage of disease transmission among fusions
January	54
February	37
March	38
April	37
May	75
June	75
July	55
August	58
September	62
October	22
November	64
December	32
Average for 12 months ..	41

The disease transmission was highest in the months of May and June, which is the period of greatest vegetative activity of sandal. The poorest results were obtained from inoculations in the month of October.

Discussion.—From the results of inoculation under different methods detailed in this paper, it is evident, that except in the case of twig-grafts, organic connection between the diseased graft and the healthy stock does not always develop the disease and the percentage of success varies with the kind of graft employed. As already mentioned, the twig-grafts contain a large quantity of infective material, while in other kinds of grafts, a lethal dose of the virus may not always be present. In a previous paper (12) we have pointed out that the spike virus travels only through some of the tissues of the bark and not through the wood.

It is not known if the virus is uniformly distributed in the former tissue. It is possible that the virus might travel through one side of the stem or branch and a bud or a patch bark-graft taken from the opposite side may not contain the infective agent. To overcome this possible contingency, we tried the method of ring bark-grafts, as it includes the entire region of tissue through which the infection must have travelled, and in addition the movement of the sap in the plant inoculated is forced to pass through the ring of infected tissue. But even in this method, 59 per cent. of the fusions failed to transmit the disease. If the variations in disease transmissions due to seasonal factors is taken into consideration, there still remains 25 per cent. of failures to be accounted for by other causes.

In other virus diseases where budding and grafting are the only known mechanical methods of infection, buds and grafts whenever they form connection, invariably transfer the infection. Smith (11) working with Peach Yellows, which resembles sandal spike to some extent, found that buds and bark grafts always communicated the disease, whenever they fused with the stock. Kunkel (7) working with Aster Yellows got similar results. As such inoculations behave differently in the case of spike disease, it has to be concluded that

though grafts contain the infective principle, the quantity or the concentration may not always be sufficient to induce the disease. It may indicate that a minimum quantity of the virus is necessary to infect plants, which however is not influenced by the size of the plant. This minimum apparently seems to vary with individuals, as ring bark-grafts of the same dimensions taken from the same twig, while infecting some plants, fail to develop the disease in others though the hosts provided are the same. In nature also similar instances have been noticed, where a few sandal trees in heavily spiked areas appear to resist the infection for a number of years before they succumb to the disease, probably after repeated infections.

It is therefore probable that some individuals are more resistant to the disease than others, and it will be worth while to select and breed the former in spiked areas.

Communication of the disease through the haustorium.—As already stated Coleman (6) showed that the disease could be transmitted through the haustorium. During the first three years, after starting pot-culture experiments, we did not succeed in transmitting the disease through the haustoria, though in over 80 pots 2 to 4 sandal plants were grown in each and one plant inoculated with spike. In subsequent years with larger plants 3 to 5 years old, the disease was successfully transmitted through the haustoria in several cases. An examination of the roots in these two cases revealed the cause of this difference.

The haustoria in young sandal plants 2 to 3 feet high are incapable of attacking the larger roots of adjacent sandal plants. They attack only the small fibrous roots. In infected sandal plants the fibrous and young roots all die soon after the sandal develops the disease, probably before the virus has travelled into the root system and hence the adjacent healthy sandal plants, being incapable of attacking the larger surviving roots of the infected plants, do not catch the infection. The failure to communicate the disease through haustoria in the first three years was apparently due to this cause, as the plants were rarely more than 3 feet high during this period.

In the case of older plants 5 to 8 feet high, where the disease was successfully transmitted through the haustoria, the haustoria of the

uninoculated sandal appeared very aggressive. They had not only attacked and penetrated the large roots of the adjacent infected plants, but also their own roots. Several haustoria were also found attached to the inner surface of the pots in which the plants had been grown.

Hence in the case of young saplings, during the first three years, there is scarcely any possibility of the disease being communicated through the haustoria, and this may partly account for the low incidence of the disease among young saplings.

SUMMARY.

(1) Different methods of inoculation by which spike disease of sandal can be transmitted are described. The fundamental principle in all methods is the grafting of infected tissue on healthy stocks.

(2) Twig-grafts which contain a large quantity of infective material always transmit the disease without exception whenever the grafts fuse with the stock. In all other methods of inoculation, that is, buds, patch bark-grafts, ring bark-grafts, and leaf-insertion, though organic connections are formed, the disease develops only in certain percentage of cases varying from 17 to 63 per cent. depending on the kind of graft used.

(3) It is therefore suspected that unlike other similar virus diseases, a minimum amount of the infective agent may be necessary to transmit the disease. There is also indication that some individuals offer more resistance to infection than others. Severe pruning of plants appears to weaken their power of resistance.

(4) To ascertain, if there is any seasonal variation in disease transmission, monthly inoculations with ring bark-grafts were conducted all round the year. The highest percentage of transmissions was found among plants operated in the months of May and June, the period of greatest vegetative activity, and lowest among those inoculated in October.

(5) The disease is generally not transmitted through haustoria in the case of young saplings 2 to 3 feet high, as their haustoria can attack only the small tender roots of other sandal, which in the case of spiked plants are all dead.

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HYGROSCOPICITY OF TREE BARKS.

BY S. N. KAPUR AND D. NARAYANAMURTI, SEASONING SECTION, FOREST RESEARCH INSTITUTE.

1. *Introductory.*

The present investigation was mainly undertaken in response to an enquiry regarding the variation in weight of stored *Cinchona* bark with changing atmospheric conditions. It is a common practice in *Cinchona* factories and plantations to dry the green bark in the open for some time, and then weigh and store it in sheds. It does not appear to be the custom to find the moisture content of the bark prior to storage, and the weight only as found at the time is entered in the records. It is, therefore, not surprising that checking officers often find a discrepancy between the original weight of the bark as shown in the books and that at the time of checking, and if the weight at the time of checking is less than the weight shown in the books, the " loss of bark " has to be written off. This investigation was primarily undertaken in connection with one of such " losses," in which the controlling officers had become alarmed at the sudden " disappearance" of a lot of bark in the hot weather. The results recorded should not only be of use to *Cinchona* factories, but also to other industries using barks, as it is evident from this investigation that all barks behave more or less in a similar manner. Moreover, no data on the sorption of moisture by barks appear to be available in the literature.

It is well-known that organic materials of fibrous or colloidal nature, like wood, paper, textiles, soap, hair, catgut, leather, peat, etc., take up or lose moisture with variations of atmospheric humidity. Any of these materials, when brought in contact with air of a definite humidity and temperature, attains a definite moisture content, which is designated as the equilibrium moisture content of the substance under those conditions. If the substance contains more moisture than the equilibrium value, it will go on drying till that value is reached. Conversely, if it is drier, it will pick up moisture till the equilibrium value is again attained. For some materials, like wood, wool and hair, the effect of temperature is not very large. The

retention of moisture by these substances is attributed to the adsorption of water molecules on the micellar surface which in area is very large. Stamm (J. Phys. Chem., 1929, **33**, 398.) has estimated that the adsorbing surface for 1 gm. of wood substance is about 310,000 sq. cm. For cellulose, based on the x-ray data of Meyer and Mark (*Cellulose Chemie*, 1930, 11, 91.), this works out to about $5 \cdot 12 \times 10^6$ sq. cm. per gram. Sheppard and Newsome (*Jour. Phy. Chem*, 1933, **37**, 389) from direct adsorption limits get for "diacetates" of cellulose 6×10^6 sq. cm. per gram. On the micellar hypothesis for cellulose one can by a simple calculation show that to have a mono-molecular layer of water, 1 gm. of cellulose will take up about 0·25 gm. of water, which is about 25% of its own weight. From actual experiments it is known that wood takes up about 25% to 30%, hydrate cellulose 23%, and native cellulose about 16% of their weights. The present experiments indicate that the maximum amount of moisture adsorbed is about 25% of the weight of the bark. The mechanism of the adsorption of vapours by porous adsorbents has been the subject of much debate in recent years. Zsigmondy (*Zeit. Anorgan. Chemie*, 1911, **71**, 356). Patrick (*Jour. Phy. Chem.*, 1925, **29**, 601) and others favour the view of capillary condensation. The fact that the adsorption isotherm for higher pressures becomes convex with respect to the pressure axis is taken as evidence of capillary condensation (vide Huckel, *Trans, Farad. Soc.*, 1932, **28**, 382). But it has been shown by Katz (*Trans. Farad. Soc.*, 1933, **29**, 279) that even non-porous bodies show this type of curve. The generally accepted view at the present time seems to be that the first part of the vapour is held purely by sorption forces, which act by satisfying the exposed valencies and the balance is held by capillary condensation (McBain *et al*, *Trans. Farad. Soc.*, 1933, **29**, 1086). It is an interesting fact to record that leaves (vide Dunlop, *Jour. For.*, 1932, **30**, 421) and the wood from the stem and the bark of trees show a maximum sorption of about 25% to 30% moisture.

2. *Experimental.*

Previous workers in this field of research have adopted Van Bemmelen's technique, which consists of placing the samples in large

desiccators containing sulphuric acid of the required concentration. The great drawback with this method is that the time required for attaining equilibrium is very long, and in almost all cases, the equilibrium value attained is lower than that obtained in a current of circulating air.

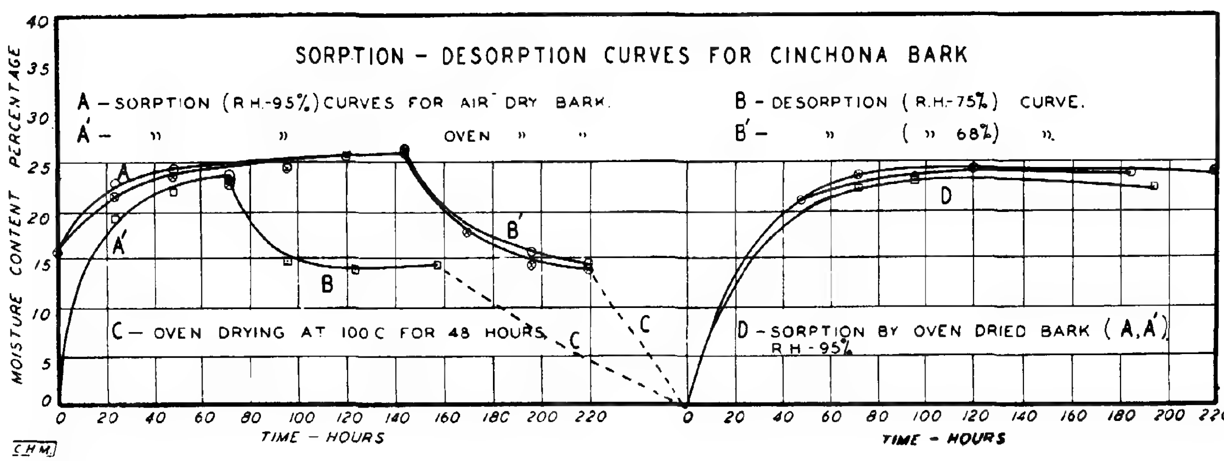
All experiments recorded in this paper were, therefore, carried out in carefully controlled air conditioning chambers, described elsewhere (*Current Sc.*, 1934, **2**, 483). The apparatus consisted of a closed chamber in which the air was circulated by means of a propeller fan, and the relative humidity maintained by means of saturated salt solutions. The desired temperature was regulated by means of heating elements, operated by contact thermometers and mercury switch relays.

Experiments with Cinchona bark.—The bark, which was obtained from one of the pharmaceutical works, on examination was found to consist mainly of the *succirubra* variety.

a. *Sorption of moisture by oven-dry bark.*—A quantity of the bark was dried to constant weight at 100°C in an electrical oven and then placed in one of the air conditioning chambers running at 95% relative humidity. After it had reached an equilibrium value it was transferred to one at about 72% relative humidity. The results are shown in Fig. I.

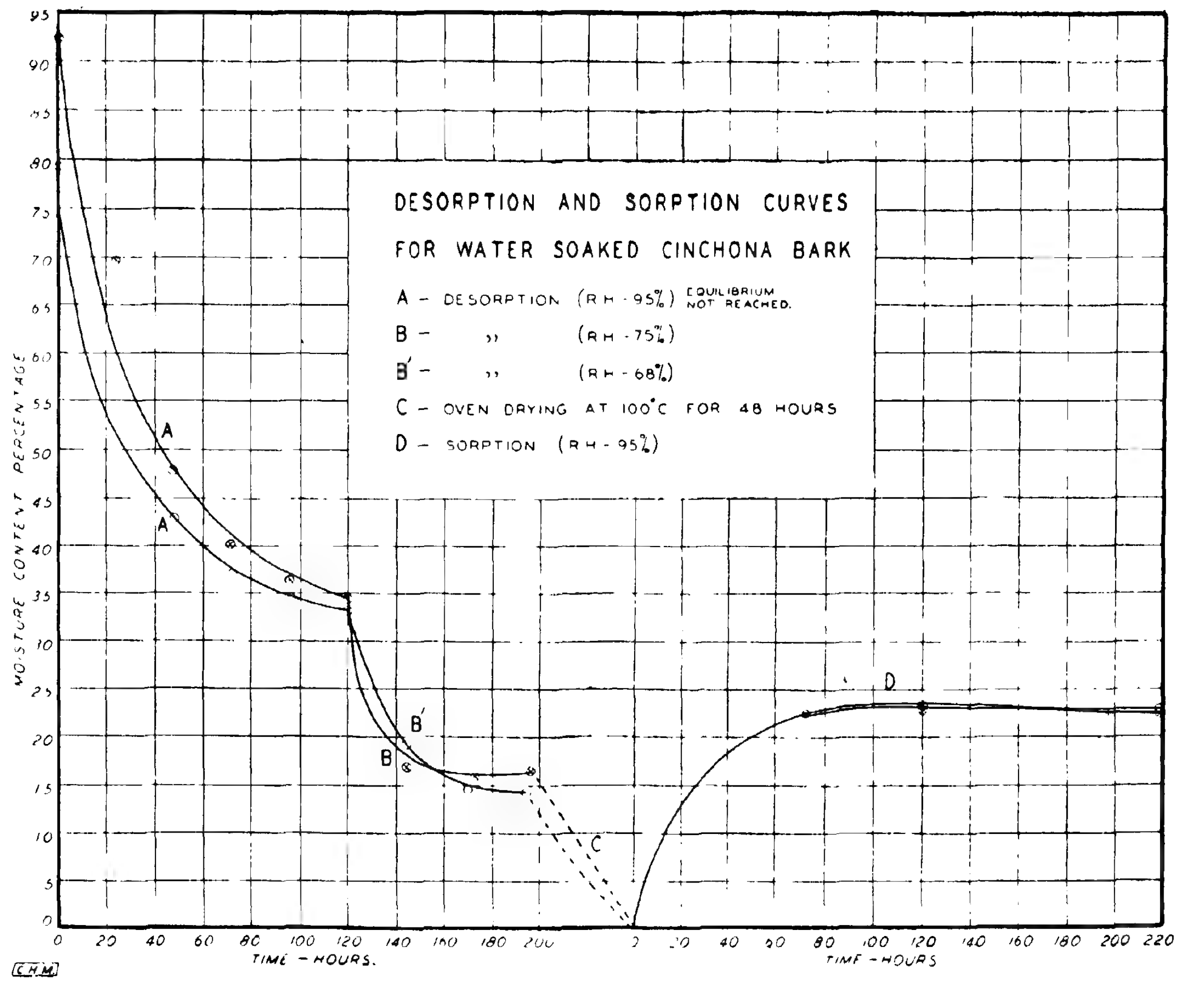
b. *Sorption and desorption of moisture by air-dry bark.*—Two lots of air-dry bark were put in a chamber running at about 95% relative humidity, then transferred to one running at a lower humidity, thereafter dried in an oven to constant weight and finally put in a chamber running at 95% relative humidity. The results are represented graphically in Fig. I.

c. *Desorption experiments with pre-soaked bark.*—Two lots of bark were soaked for 24 hours in distilled water and then placed in a chamber running at 95% relative humidity. Later they were transferred to a chamber at a lower humidity and finally dried in an oven to constant weight. They were then again put in a chamber running at 95% relative humidity. The results are shown in Fig. II.



SORPTION - DESORPTION CURVES FOR CINCHONA BARK
A - SORPTION (R.H.-95%) CURVES FOR AIR DRY BARK.
A' - " " OVEN " "
B - DESORPTION (R.H.-75%) CURVE.
B' - " (" 68%) ".
C - OVEN DRYING AT 100 C FOR 48 HOURS
D - SORPTION BY OVEN DRIED BARK (A, A') R.H.-95%
A
A'
B
B'
C
D
MOISTURE CONTENT PERCENTAGE
0
5
10
15
20
25
30
35
40
TIME - HOURS
0 20 40 60 80 100 120 140 160 180 200 220
TIME - HOURS
0 20 40 60 80 100 120 140 160 180 200 220
C.H.M.

Fig. I.



DESORPTION AND SORPTION CURVES
FOR WATER SOAKED CINCHONA BARK
A - DESORPTION (RH - 95%) EQUILIBRIUM NOT REACHED.
B - ,, (RH - 75%)
B' - ,, (RH - 68%)
C - OVEN DRYING AT 100°C FOR 48 HOURS
D - SORPTION (RH - 95%)
A
A
B
B'
C
D
MOISTURE CONTENT PERCENTAGE
TIME - HOURS.
TIME - HOURS
C.H.M.

Fig. II.

The results obtained show that *Cinchona* bark behaves like other fibrous materials, especially wood. The equilibrium moisture content found by extrapolation of the curves to 100% relative humidity (otherwise called the fibre saturation point) is about 24%, thus closely agreeing with that for wood. It will also be seen that all the lots, even after different treatments, when placed in an atmosphere of 95% relative humidity attained almost the same moisture content.

Experiments with other barks.—In order to see whether different barks behave in different ways, some further experiments were undertaken. Barks of toon (*Cedrela toona*), jaman (*Eugenia jambolana*) and mango (*Mangifera indica*) were studied. The barks were taken from trees near the laboratory and the experiments were started immediately. The barks were separated into as many layers as possible and weighed. As will be seen from the following table, the initial moisture content varied from 13% to 573%. The samples were kept in an air conditioning chamber running at 35°C and 90%

TABLE I.

Bark.		Initial Moist. content.
Cinchona (air-dry).	..	13·5
Ditto.	..	13·2
Toon, whole section	..	161·2
,, outer section	..	18·7
,, middle section	..	114·4
,, inner section	..	242·4
Jaman, whole section	..	165·0
,, outer section	..	142·3
,, inner section	..	131·1
Mango, whole section	..	140·7
,, outermost section	..	21·5
,, outer section	..	166·5
,, middle section	..	158·1
,, inner section	..	573·1

relative humidity. After attaining equilibrium they were transferred to one running at 72% relative humidity, then to one at 52% relative

humidity, thereafter to one at 41%, and finally dried in an oven at 100°C. The results are given in Figs. III to VII.

As will be seen from the curves, all the samples behaved in a more or less similar manner. They all have a fibre saturation point of about 22% to 28%.

The results, on the basis of the theory of capillary condensation, indicate that capillary condensation is more pronounced with outer than with inner bark. It is most pronounced with jaman, and the least with toon whole bark. It will also be seen from the curves that the deviations of the various sections from one another is least with mango and jaman and the greatest with toon.

For the sake of comparison, sorption values at 90% relative humidity for various materials are given in Table II below.

TABLE II.*

Material.	% water vapour sorbed at 90% R. H.
Wood ..	22
Jute ..	20
Manila hemp ..	16
Flax ..	15
Paper, kraft, wrapping ..	15
Paper, newsprint ..	11
Nitro-cellulose ..	16
Silk, natural ..	23
Wool, worsted ..	23
Leather, sole, oak-tanned ..	30

Before closing, the significance of the above data in pharmacy and industry may be emphasized. Stems, roots, barks, leaves and other tissues of various trees and plants find application in pharmacy and industry. Tinctures and extracts are made from *Cinchona* bark

*Values obtained from the *International Critical Tables*, Vol, II, 1927, p. 321.

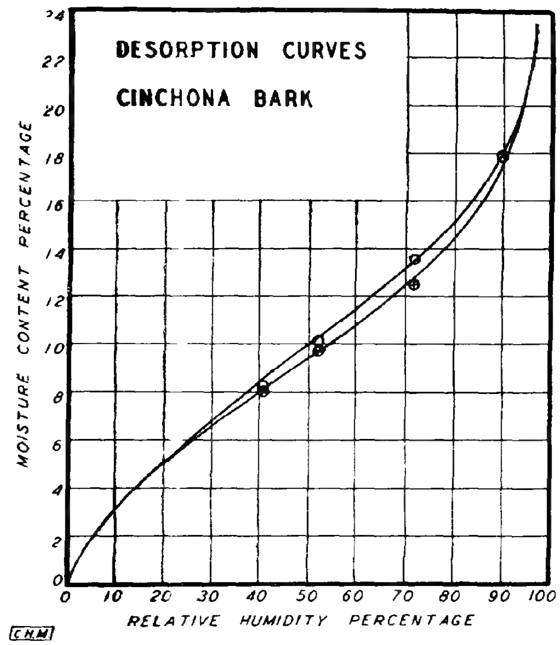


Fig. III.

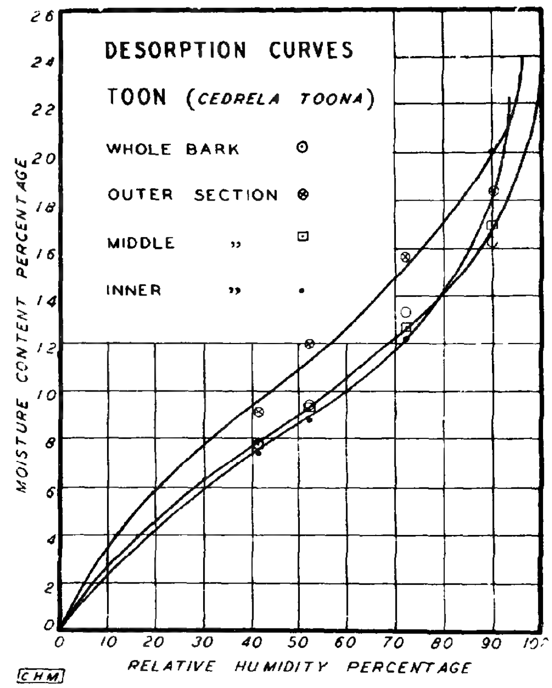


Fig. IV.

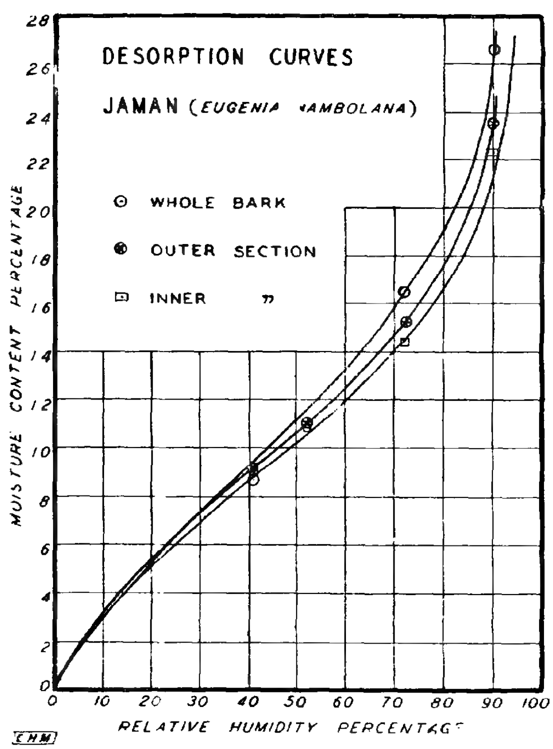


Fig. V.

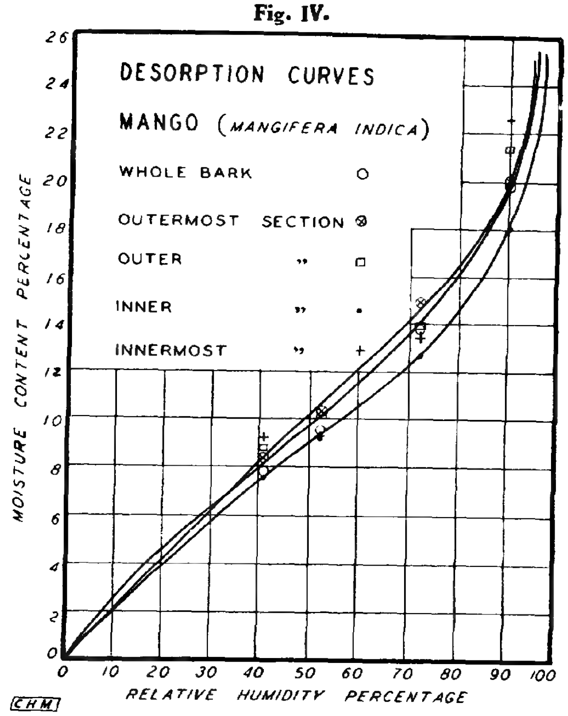


Fig. VI.

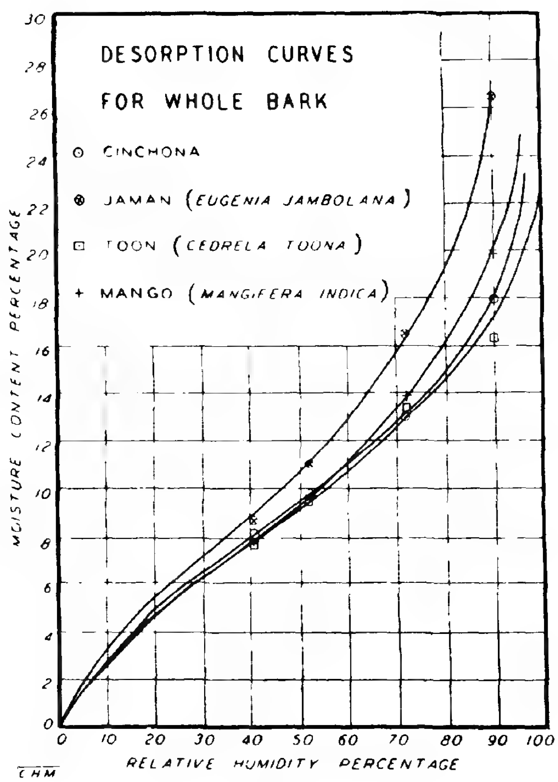

DESORPTION CURVES
FOR WHOLE BARK
CINCHONA
JAMAN (EUGENIA JAMBOLANA)
TOON (CEDRELA TOONA)
MANGO (MANGIFERA INDICA)
MOISTURE CONTENT PERCENTAGE
RELATIVE HUMIDITY PERCENTAGE
0
10
20
30
40
50
60
70
80
90
100
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
CHM

Fig. VII.

and from *Cascara sagrada*. *Digitalis* and other drugs of organic origin. As the weight of dry bark in an air-dry condition as used for the preparation of these extracts and tinctures will vary with the season of the year—especially in tropical countries where the temperature and humidity vary from one extreme to another—it is important that the moisture content should be determined prior to use. Unless this is done, the strength of the preparation is bound to vary. The importance of this to other industries like tanning, where barks are used, may also be mentioned.

SUMMARY.

Experiments on the sorption of aqueous vapour by various barks at various humidities have been carried out for the first time.

The results indicate that tree barks, with regard to sorption of water vapour, behave similar to wood.

The maximum sorption at saturation humidity varies from 22% to 28%.

Oven-drying does not reduce the sorption of water vapour by bark appreciably.

The mechanism of sorption of vapours by porous adsorbents is very briefly discussed.

The importance of the data obtained to pharmacy and bark using industries is emphasized.

ACTINODAPHNE AND LITSAEA FATS AS RAW MATERIAL FOR A VALUABLE NEW DETERGENT.

By S. V. Puntambekar, M.Sc., Ph.D., Chemical Branch, Forest Research Institute.

The fat of *Actinodaphne hookeri* as an indigenous source of lauric acid has already been pointed out in a publication (1) from this Branch. In view of the fact that sodium lauryl sulphate is coming into considerable prominence as a new detergent approaching the ideal, an

opportunity is taken to suggest that this and the similarly constituted fats of the *Litsaea* species (N. O. Laurinaceae), over sixty varieties of which are known to be found all over the country, could serve as better raw material for the preparation of the detergent than the coconut and palm kernel oils (trilaurin content about 50%) used at present. This is apparent from the high trilaurin content of some of these Laurinaceae fats, namely, *Actinodaphne hookeri* (96%), *Litsaea sebifera* (96%) and *Litsaea zeylanica* (85%).

The recent achievements in the high temperature and pressure hydrogenation (2) have made it possible to convert fats and fatty acids directly to the corresponding alcohols, which are the basic materials for the new type of detergents. Thus by this process trilaurin could be easily converted into lauryl alcohol from which sodium lauryl sulphate is obtained by a simple process.

That this new detergent possesses certain properties which are superior to those of the ordinary soap is well brought out in the interesting papers (3) on the subject, by Killeffer and Duncan. They have shown, for instance, that the amount of sodium lauryl sulphate required for washing is practically independent of the hardness of water, whereas the amount of the soap required to do the same work increases rapidly with the hardness. This is because its calcium and magnesium salts, unlike the calcium and magnesium salts of the high molecular weight fatty acids, are themselves good sudsents and good detergents. Furthermore, sodium lauryl sulphate is not affected by salt as the ordinary soap is and, therefore, performs as well in sea water as in tap water.

In textile works where soap is used in large quantities these defects mean not only high expenditure but also considerable depreciation of the finished articles, especially when the water is hard and the dyeing of the textiles has to be carried out in an acid bath. Thus the precipitation and deposition of the calcium and magnesium salts of fatty acids on the fibres produce disagreeable odours due to their slow decomposition into rancid products. Also, if after scouring and before introduction into the acid dyebath, the textiles are not completely freed

from the soap, even traces of the fatty acids, produced by its decomposition, would prevent uniform dyeing. All these difficulties and handicaps are, however, easily and completely overcome when sodium lauryl sulphate is used in place of soap.

Further use of lauric acid salts has been made in entomology. It has been, for instance, reported (4) that sodium laurate is a better contact agent for insecticides than the ordinary soap and in this respect they have found that in concentration of 0·25 to 0·5 % it gave optimum results against most of the experimented insects.

Recently sodium lauryl sulphate has been found very useful as 'spirit cleaner' in which case a small amount of it is dissolved in hydroalcoholic mixture containing about 35% alcohol and 5% glycerine. It is being sold in the U. S. A. as 'Gardinol W. A.' in the textile trade and as 'Orvus' in other bulk supplies; and these developments in the field of soap industry have met with considerable trade acceptance.

The high trilaurin content of the Indian *Litsaea* fats and their widespread supply are very encouraging factors for the manufacture of sodium lauryl sulphate in this country and the sooner a beginning is made the better it will be for the interested consumers.

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THE CONIFERS OF THE SIKKIM HIMALAYA AND ADJOINING COUNTRY.

BY E. O. SHEBBEARE, CONSERVATOR, BENGAL.

The coniferous trees occurring naturally in Sikkim are the following :—

	English	*Nepalese*	*Tibetan.*
Abies densa ..	Silver fir.	Gobre-salla.	Dungshing (or Somshing ?).
Taxus baccata ..	Yew.	Dhengre-salla.	Tingshi.
Tsuga brunoniana ..	Hemlock.	Tingre-salla.	Semadoong.
Pinus excelsa ..	Blue pine.	Dhupi.	Me-Tung (or Tongshi ?)
Larix griffithii ..	Larch.	..	Sa-Shing.
Picea spinulosa ..	Spruce.	..	Se-Shing or Hle-Shing.
Juniperus pseudosabina	Tree juniper.	..	Tchok-po. Shuk-pa.

In addition, it is necessary to mention *Cupressus funebris*, commonly planted, especially near monasteries ; *C. cashmiriana* (Tib. *Tshen-Den*) about which little is known but which may be the eastern representative of *C. torulosa* of the W. Himalaya ; *Cryptomeria japonica* extensively planted especially near Darjeeling ; *Pinus longifolia* (Tib. *Tea-Dong*. Lepcha, *Gniet-Kung*) of which restricted outlying colonies occur in the Tista Valley ; and finally the dwarf juniper, *Juniperus recurva* (Tib. *De-Schoo* or *Shuk-pa*).

The distribution of these trees, and the causes underlying it, are of considerable interest, and the following notes have been collected to summarise existing records on the subject.

1. *The Jalap La between Sikkim and Bhutan.*—West side (Sikkim valley).—Silver fir up to 13,300 ft. East side (Chumbi valley)—Silver fir (with dwarf *Rhododendron* and juniper) higher than on west side. At 12,300 ft., pure silver fir with *Rhododendron* undergrowth. At 11,500 ft., good regeneration of silver fir. At 10,500 ft., spruce begins. Lower down, blue pine mixed with occasional spruce and silver fir ; perhaps some hemlock.

2. *The Natu-La between Sikkim and Bhutan.*—This pass is close to the Jalap La, a few miles to the N.-W. of it.

W. Side (Sikkim Valley).—Tree growth (silver fir) ceases at 12,000 ft. The silver fir has an undergrowth of *Rhododendron* and birch. Lower down there is some juniper (presumably *Juniperus pseudo-sabina*).

E. Side. (Chumbhi Valley). Silver fir, 12.000 ft. to 13,300 ft. with undergrowth as above. Break from 11.500 ft. to 12,000 ft., and below 11.500 ft., blue pine and spruce with a few juniper, presumably *Juniperus pseudo-sabina.*

3. *Yatang to Gautsa, Chumbi Valley.*—Yatang is in Bhutan about 12 miles N.-E. of the Jalap La, and Gautsa is some 10 miles N.-E. up the valley.

At 10.000 ft., blue pine with a few spruce and juniper. At 10,500 ft. larch begins, spruce and juniper remaining (blue pine dropping out ?). Larch in pockets from 10,500 ft. to tree limit at 12.500 ft. *Juniperus pseudo-sabina* plentiful at 11,000 ft. At 11,500 ft., spruce, juniper and birch. At about 11,500 ft. silver fir begins, and this and birch continue as principal species up to tree limit (12,500 ft.).

4. *The Lachen Valley, N.-E., Sikkim.*—At 13,000 ft., a few stunted juniper with birch, willow, and rowan (*Pyrus aucuparia*). At 12,000 ft., stunted silver fir. At 10,000—8,000 ft., hemlock and spruce. Larch in pockets from 11,000 ft. downwards (to 8,000 ft.).

5. *The Rangit Valley, S.-W. Sikkim.*—Hemlock occurs freely and is often of fine growth at elevations at 8—10,000 ft., particularly on well drained ridges such as the slopes to the north of Ramam, though it is somewhat local. Tree juniper is met with in a few places as on the slopes S.-E. from Kang La, but is more commonly seen only as a dwarf shrub mixed with *Juniperus recurva* (*e.g.*, at Dzongri). Silver fir is found on moraine and gravel soils from 10,000—12,000 ft. usually with an underwood of *Rhododendron*; it does overlap the hemlock below it, but is more usually pure. Spruce, blue pine and larch do not occur east of the Pandim ridge.

6. *Tanglu and Singalila Ranges of Darjeeling Forest Division.*—Silver fir forms extensive forests above 10,000 ft., sometimes in fairly complete canopy but more usually scattered singly or in groups over *Rhododendron* (especially *R. campanulatum*) or *Arundinaria*. Fires and damage incidental to grazing have greatly influenced these forests, large areas, particularly along the hill tops, having been destroyed whilst others are moribund. Hemlock is restricted to the more northerly ridges and slopes where the full force of the monsoon is not experienced, as near Ramam, though it is said that outlying groups rather further south have disappeared not so long ago. Yew occurs scattered in the oak forests between 8,000 and 10,000 ft., singly or in groups, but is not very common anywhere.

7. *The Kharta Valley, Nepal.*—Fine juniper forest.

8. *The Kosi Valley, Nepal.*—Sherpas say there is blue pine. The Rongsher valley to the east of Gaurisankar is included here. It was visited during the 1924 Everest Expedition and so notes on its vegetation are available. On the east side at about 10,000 ft. are fine crops of hemlock mixed with silver fir and larch, whilst on the west bank, the conifers are much mixed with broad leaved forest. At 11,000 ft. two or three yew trees were noticed but may have been planted. Larch and silver fir extend up to 12,500 ft. and the scrub junipers—both species but mostly *J. pseudo-sabina*—extend up to 14,000 ft. or even higher.

These notes may be summarised for the several species as follows:—

Silver fir.—Occurs over the whole east to west range from 10,000 ft. to 13,300 ft. or so, and into the hills up to the Lachen Valley.

Yew.—Occurs between 8,000 and 10,000 ft. in the outer ranges but is not common anywhere; apparently planted in some localities near monasteries.

Hemlock.—Occurs between 8,000 and 10,000 ft. except in the outer ranges with heavy rainfall.

Blue pine.—Occurs between 10,000 ft. and 11,500 ft. in the Chumbi Valley to the east of Sikkim and probably in the Kosi Valley to the west, but has not been found in the Tista Valley, *i.e.*, in Sikkim itself.

Larch.—Occurs on fertile pockets of soil (? moraine deposits) between 10.000 ft. (or perhaps lower) to 12,500 ft. right across Sikkim but only in the inner valleys; absent from Darjeeling district.

Spruce.—Occurs from 8,000 ft. to 11,500 ft. in the inner valleys only: absent from Darjeeling district.

Tree juniper.—Occurs from 11,000 to 12,000 ft. and as a bush right up to 14,500 ft. across the whole east to west range.

CUPRESSUS CASHMIRIANA.

By C. G. Trevor.

The following letter from Sir Arthur Hill, the Director, Royal Botanic Gardens, Kew. is reproduced below. If Griffith first described the tree as *C. pendula* from Bhutan it is almost certain I think that he described the tree now known as *C. funebris*. In this number also appears an article on the Conifers of the Sikkim-Himalaya and adjoining country by E. O. Shebbeare. This authority distinguishes *C. funebris* from *C. cashmiriana* and I have asked that botanical specimens of both may be collected for examination.

Dear Sir,

"In reply to your letter No. 2379/36 of July 5th, *Cupressus pendula*, Griff. (*C. cashmiriana* Royle), has for many years presented a difficult problem. Under cultivation it is very distinct in appearance from the Indian *C. torulosa*, and has points of difference from the allied *C. funebris*, but doubts have been expressed as to its being distinct enough for specific rank. Suggestions have been made that it may be a variety of either *C. torulosa* or *C. funebris* but it is so different in general appearance to them both that it has, up to the present, been retained under a distinct specific name.

Dallimore and Jackson, "A Hand-book of Coniferae," in describing the tree direct attention to its doubtful position in the following words.—" A small tree, apparently unknown in a wild state, although stated by Carriere to be a native of Tibet." ... "This, the most beautiful

and elegant of all the cypresses, appears to be a juvenile form of *C. torulosa* which it closely resembles in its cones. It was formerly considered to be a well-marked variety of *C. funebris*, but differs from that species in the larger number of cone scales and in having about 10 seeds on each scale."

When writing of this tree people usually omit to mention the fact that it was originally described by Griffiths under the name of *Cupressus pendula* (See Griff. Itinerary Notes. ii. p. 143. 1848). The name occurs with a Latin description of the tree in the enumeration of the Bootan (Bhutan) Flora. from specimens collected by him during his expedition to the Bootan Mountains, 1837-1838. As the date of publication of the name *C. pendula* (1848) antedates that of *C. cashmiriana* by 19 years, *C. pendula* should stand if the tree is accepted as a good species, and the country of origin would appear to be Bhutan instead of Kashmir as suggested by the later name. Griffiths referred to it on his specimens as " a sacred tree," but whether he actually found it wild is difficult to say.

A package of seed has just been received from Dehra Dun under the name of *Cupressus cashmiriana*. We will pay special attention to the seedlings raised in order to ascertain whether there is much variation between them or whether the young trees are true to type. As the tree is not hardy here we will try and get someone in one of the mildest parts of the country to plant a number of seedlings in order that their development may be watched. We usually increase the tree by cuttings ; therefore all our plants are of one type.

There is just a possibility that the tree may be a natural hybrid between *C. torulosa* and *C. cashmiriana*, at any rate the cultivation of a number of seedlings may be a guide as to whether it should be regarded as a distinct species or not."

Yours faithfully,

Dated 26th July 1934. ARTHUR HILL,

DIRECTOR.

REVIEWS.

FOREST ADMINISTRATION REPORT FOR COORG, 1932-33.

That the economic depression is not by any means localised but is still very general is evident from the large drop in revenue as shewn by the Forest Administration Report for Coorg for the year 1932-33. This decrease was mainly due to the drop in prices of sandalwood, which had shown an encouraging, if slight, upward trend the previous year. The average price per ton being Rs. 833 compared to Rs. 1,029 in the previous year. The fact that only 197¾ tons were sold compared with 340 tons in 1931-32 is also partly responsible for the decrease in revenue.

Strict economy is still being practised and labour rates were reduced.

Enumeration and stock mapping in the Eastern Forests were completed during the year. Experiments conducted during the year demonstrated that sandal cannot be raised in Coorg under heavy shade.

The investigation of spike disease on sandal was continued in collaboration with the Indian Institute of Science. Rs. 2,500/- was contributed for this cause.

G. R. H.—G.

ADMINISTRATION REPORT OF THE TRAVANCORE FOREST DEPARTMENT FOR THE YEAR ENDING 16TH AUGUST 1933.

A noteworthy feature of the work in Travancore is the successful establishment of teak plantations under the *taungya* system. The Travancore Forest Department is to be congratulated on the success achieved in establishing 11,755 acres of good teak plantations at a low cost. With increased experience not only the technique has been suitably adjusted to local conditions with remarkable results but also the initial cost has been considerably reduced. During the year under review, 575 acres were planted with teak at an average

cost of Rs. 1·65 per acre. The total receipts for thinnings were Rs. 27,925. The revenue would have been still higher had it not been for the fact that as many as 25,900 saplings remained unsold for want of demand.

Serious attempts appear to have been made to expand the area under sandal. While we wish them success we would like to draw attention to the observation recorded in the report that most of the trees in Anjanad Range appear unhealthy and top-dry after they have grown to a certain size. It would be interesting to know if any of them were spiked. 474 maunds and 7 lbs. of sandalwood were collected in this range and sold for Rs. 5,437/-.

The attempt to raise *Bombax malabaricum* artificially by the *taungya* method was not a great success on account of porcupines. But cashewnut plantations are reported to be coming up satisfactorily. It is of interest to note that some trees had begun to bear fruit in their third year.

The total outturn of timber was 13,99,449 cubic feet, an increase of 1,83,028 cubic feet on the previous year ; of this 6,25,208 cubic feet consisted of teak, 33,030 cubic feet of rosewood and the rest was junglewood. The disposals amounted to 12,57,932 cubic feet consisting of 4,95,165 cubic feet of teak, 21,966 cubic feet of rosewood and 7,40,801 cubic feet of junglewood. As the market continued dull throughout the year, large stocks were left on hand at the close of the year. The balance stock consisted of teak 5,64,425 cubic feet, rosewood 33,608 cubic feet, and junglewood 1,91,691 cubic feet. It seems advisable to hold in abeyance the export duty on timber except mango and jack, while the trade depression lasts.

From the financial point of view the year under review is reported to be 'a very lean year.' The revenue realised was Rs. 12,03,353 and the expenditure was Rs. 7,98,548, leaving a cash balance of Rs. 4,04,805. The surplus, though nearly 30 per cent. of the revenue, is, however, less than last year's surplus by Rs. 1,02,939.

The Government decision to grant compassionate gratuity to the families of subordinates who die before receipt of pensions at the rate of 1 month's pay for each year of pensionable service, will be appreciated.

M. H.

ROUGH VOLUME TABLES FOR TEAK.

Burma Forest Bulletin No. 31, 1934.

These must surely be the biggest collection of detailed outturn statistics collected for any single species in India. 97 tables are given based on varying numbers of trees up to nearly 1,00,000, altogether nearly 4 lakhs of trees having been measured. The object is to supply the means of estimating to within 10 per cent. the outturn which may be expected from different types of forests in different localities, under present methods and standards of extraction, this last point being wisely stressed in the preface, as also the large errors liable to occur in particularising from the general . . . . in other words, expecting average values derived from a varying lot of data to be applicable to the relatively small individual sample. A short description is given of the locality and forest type in which each set of data was collected and outturn volumes are given in cubic feet quarter girth without bark for 3″ girth and 1″ diameter classes ; in every case the number of trees measured in each 6″ girth class is given as well as an average volume for trees 9′ in girth and over, and 12′ in girth and over. The data were supplied by the timber Lessees, and the computation work, no small undertaking, *experte credo,* done in the Silviculturist's office. These tables should be of great practical use throughout Burma, and are of considerable interest to all teak producing provinces.

H. G. C.

EXTRACTS.

WOOD CAR PREVENTS CHECKS.

There are certain types of freight which are transported more safely in cars constructed of wood. Weyerhæuser Sales Co., St. Paul, Minnesota, makes this interesting observation based on reports from one of its eastern representatives.

" We had an unusual number of complaints on shipments into Detroit last summer and there is a marked similarity in all of them. Every one of these complaints was on a shipment made in a steel car. We have discussed this with the rail-roads and they tell us frankly that there are many commodities which they are prohibited from shipping in steel cars in the summer time. They tell us there is an average of 20° difference in the temperature inside of a wooden car and a steel car in extremely hot weather and that, furthermore, the humidity within a wooden car is more nearly constant with the outdoor humidity than is that of the steel car.

" It seems significant that we can recall no kicks because of checked lumber where the shipment was carried in wooden equipment. It is our suggestion that we would not only be favouring the lumber industry but we could be helping our shipments exceedingly if we insisted on wooden equipment from the rail-roads, at least during the four or five summer months."—(*The Timberman, dated February* 1934.)

PLASTICS IN INDIA.

The hon. correspondent in India of the Plastics Group of the Society, Dr. R. W. Aldis, has submitted the following report to the Group :—

Gramophone records have been manufactured for several years in a very modern factory at Dum Dum by a flourishing concern. Climatic conditions have been overcome by introducing cooled conditioned air. The quality of the product has convincingly demonstrated that Indian labour is extremely suitable for the art of moulding. It is somewhat surprising, therefore, that other firms have not established plant for general plastics manufacture. One firm in Bombay started manufacture of articles from a synthetic resin type of material ; but this firm has since ceased work owing to the unfortunate death from small-pox of the director.

It has recently been reported that a firm in South India is considering the manufacturing of electrical insulator parts from a shellac moulding powder, but so far work on a commercial scale has not begun.

Experimental work on shellac moulding powders is being conducted at the Indian Lac Research Institute, Namkum, Bihar and Orissa. A certain amount of success has been attained and mouldings of appreciably improved heat resistance have been prepared by incorporating 3% urea or thiourea in the powder and preheating before moulding. Interesting results have also been obtained in experiments on the possibility of converting the cheap by-products of shellac manufacture into moulding powders.

Those interested in both shellac and synthetic resin moulding might well turn an eye to India where there is as yet no competition and where there should be a very large market.—(*Chemistry and Industry, May* 4, 1934.)

FOREST CONSERVATION IN UNITED STATES BECOMES OBLICATORY AFTER JUNE 1. 1934.

All forest owners under the Lumber Code must obey new forestry rules. Lumber Code Authority carries out reforestation promise to the President.

The Lumber Code Authority recently adopted what is virtually the primary reforestation law for all commercial timber lands subject to the code governing the

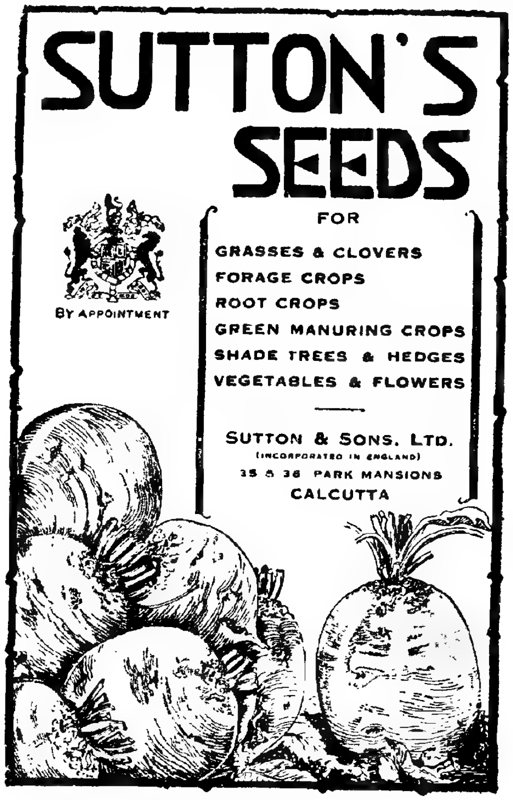
lumber and timber products industries. Broad basic rules governing forest operations were written into a forestry code and added to the Lumber Code as Supplement C. This forestry code is as binding on the forest industries in respect of maintaining their forests in a reproductive condition.

When the supplement is approved by President Roosevelt it becomes in effect the federal law of the forests.

The new law will apply at once to about 250 million acres of land owned by industrial timber holding companies and to that portion of the 125 million acres of farm timber lands. The total forest area of the United States is over 500 million acres, of which 180 million acres are in national and state forests or some other form of public domain.

It may be said that the United States now becomes one of the countries whose forests are entirely under conservative utilization. The basic rules for the country as a whole are as follows :—

(1) Protection of standing timber and young trees from fire and other destructive forces. (2) Prevention of damage to young trees during logging operations. (3) Provision for replanting the cleared land after logging, if sufficient advance growth is not already present. (4) To leave, where feasible, some portion of the merchantable timber as a basis for growth for the next timber crop. (5) Partial cutting or selective logging shall be the general standard of forest practice.—(*Southern Lumberman*. Vol. 148, No. 1869, p. 15, Feby. 15, 1934. *Reprinted in Makiling Echo, April* 1934).



INDIAN FORESTER,

NOVEMBER, 1934.

PRESERVATION OF WILD LIFE.

We reproduce an excellent article written by F. W. Champion in the *Bombay Natural History Society Journal* for April 1934 on the position in the United Provinces with regard to the Preservation of Wild Life. Wild life for ages furnished humanity with necessary food when primitive man came down from the trees and learnt that there were other means of subsistence than fruits and leaves. Wild animals continued to supplement human food requirements even when man had taken to cultivation and this holds true even at the present day. For a long time the fight was equal, as man only killed for food and seldom for pleasure, and did not possess the deadly weapons which modern civilisation has given him, and which endow him with a preponderable advantage in the contest.

Mankind will only be doing a good turn to the animal kingdom, which maintained him through the ages and which is now threatened with extinction, if every one would adopt real sportsmanship in shikar and avoid killing animals for the mere sake of destruction.

National Parks and Bird Sanctuaries have been successfully constituted in other countries and far from being a drain on their finances are paying for their upkeep in addition to providing pleasure to the public.

The Forest Officer is in a particularly advantageous position to help in this cause as he spends most of his time in the country and has large forest areas, the natural home of all wild life, in his charge. Given a reasonable balance of nature and a reasonable head of game the requirements of silviculture should not conflict with the preservation of wild life.

Next to the forest officer is the important landowner who can do a great deal in preserving wild life on his estates.

We welcome the inauguration of a Society in the United Provinces devoted to this object whose Secretary is issuing an appeal to all true sportsmen to attend the first All-India Conference for the Preservation of Wild Life to be held in X'mas week in Delhi in 1934 on the lines of the International Conference for the Protection of Fauna and Flora of Africa held in London in 1933.

We strongly support the appeal and hope that forest officers and landowners will join the Association and do all they can in this most deserving cause.

If every District Officer can persuade a few country gentlemen from his district to attend the conference and at the same time to join the Association he will be doing real service to the cause. These are the men who can set a good example to the commoner folk in observing close seasons, in not killing sitting birds, and destroying young animals, in particular females in and out of season.

Note.—Since the above was written the Government of India have decided to hold the Conference under their own patronage and the date is likely to be 28th January 1935.

LIFE IN A HIMALAYAN VALLEY.

BY E. C. MOBBS, I.F.S.

II.—Occupations and General Life.

Cultivation and the rearing of sheep and goats and of sufficient cattle to provide oxen for the agricultural work are the main occupations of the people of the Tons Valley. The fields are terraced and frequently irrigated. Channels are constructed from small ravines or from the tributaries of the main river, and are frequently carried long distances along the mountain sides to the fields. Where the slopes are gentle the fields are moderately wide and the terracing slight, but in the steeper parts the width of a field is sometimes less than the height of the wall that supports it. Such fields have been constructed gradually, taking years to complete, and once made they are very carefully maintained.

In the uppermost parts of the Tons Valley the soil is much poorer than lower down and very poor crops are obtained from established fields. Shifting cultivation is therefore practised in addition to the regular cultivation of terraced fields. This has undoubtedly caused the destruction of what must at one time have been very good forest, and although officially prohibited, shifting cultivation is still preventing potential forest from developing. It seems necessary, however, to permit it to a certain extent, and as all the more valuable forests have been demarcated and reserved, there seems little harm in permitting shifting cultivation in the poorer forests between the reserves and the villages.

This, however, only applies to the uppermost parts of the Tons Valley. In the greater part of the district the soil is fairly fertile and cultivation is only carried out in permanent terraced fields, which are regularly ploughed and manured.

The crops raised are mainly wheat, barley, various millets and pulses, and rice. The last is naturally only grown in the warmer and damper valleys, and is only a poor variety, not to be compared with the rice of other parts of India. The rice fields are often made to produce two crops a year; wheat and barley in winter and rice in summer. But for the most part it is far too cold for anything to be produced in winter and only one crop per year can be raised. Only essential foods are grown, little being produced in the way of luxuries, such as vegetables or fruits. But certain spices, notably mustard and pepper, a little tobacco of a poor type, and a little white opium are also grown. Potatoes are grown in some of the higher villages, where they are said to have been introduced years ago by a Forest Officer.

Agricultural implements are few and crudely constructed of timber obtained locally from evergreen oaks and rhododendrons. Small hill oxen are used for ploughing, which is done by the men. The men also sow the seed, but the women and children do the rest of the field work; weeding where necessary, cutting the ripened crops, and carrying the harvest to the village. No form of wheeled transport is known, nor would it be of any use on the steep mountain slopes or on the

terraced fields, so all the harvest has to be carried on the back. The men often assist in this carrying work, but the major part is done by the women.

The children have no schools to go to, and from a very early age they begin to work with their mothers. Tiny boys will collect sticks for firewood while their mothers are working in the fields, and will carry them on their backs as they toddle bravely back to the village. Small girls have their little baskets and will trudge along with their mothers, bringing home their small share of the harvest. As soon as they get old enough, they assist in the more strenuous work of weeding and harvesting.

Rice and sometimes also wheat and barley are threshed in the fields by means of oxen, who trample out the grain in the typical Eastern way. The old Mosaic law "Thou shalt not muzzle the ox when he treadeth out the corn" is not observed. The oxen are invariably muzzled and tramp on and on, sometimes for hours.

Other grains are threshed in the village by the women and girls, each house usually having a stone paved courtyard for the purpose. The seed is pounded with long wooden poles in holes made in the stones of the courtyard to loosen the husk, and the winnowing is done by shaking up the mixture of grain and chaff in small trays, made like the bigger baskets from a small local bamboo. With the lighter seeds, such as "chaulai," a purple Amaranth, the husk is so light that it is sufficient simply to let the seed drop from shoulder height to the ground, the slightest breeze sufficing to blow the husk away. The men occasionally help in the winnowing work, but it is usually left to the women and children, while the men plough up the fields from which the harvest has just been reaped.

The seed is stored in the houses, or it may be kept in separate granaries constructed near the houses. A granary is just like a miniature house, raised a little above the ground level to keep it dry. The lower part is properly floored with wooden boards and is divided by partitions into a number of compartments, which are reached by trap-doors in the floor of the upper half. The grain is simply poured

LIFE IN A HIMALAYAN VALLEY.

11. The children begin to work from a very early age.
Little boys bring home sticks for firewood that they have collected when out in the fields with their mothers or when on the mountain sides with the sheep and goats.

12. When quite young, girls assist in the field work and in bringing home the harvest. This girl is carrying a basket of *chaulai*, a purple Amaranth which ripens in September, when the terraced fields become brilliant purple patches on the mountain sides.

Photos by E. C. Mobbs.

through the trap-doors, which are big enough to allow a man to pass through when the stocks become low. The door of a granary has no lock, but is pulled to by means of a long chain connected to the house of the owner. The chain has bells hanging from it. So anyone attempting to open the granary door by night would pull the chain and cause the bells to ring, which would rouse the owners and their ferocious dogs.

Where there is sufficient water power near by, the grinding of the seed into flour is done by primitive water mills. Otherwise the grinding is done by the women from day to day. After the sun has set and all the people and animals are safely back in the village for the night, the whole village is filled with the noise of the grinding in each house for the evening and the following morning meals.

As they get older, say ten to fourteen, the boys are often sent out with the sheep and goats, while the older boys take out the cattle. I have often camped near a village and watched the boys go off in the early morning with all the sheep and goats of the village. In true Eastern fashion they lead their flocks, whistling and calling to them as they go. The animals understand each call and go up hill or down hill or straight along, or stop for a good graze in one place, according to the call. On their backs the boys carry some flour and a cooking vessel for preparing some food in the middle of day. For although the older people only have two meals a day, in the morning and evening, the children all have a mid-day meal. The boys take the animals slowly over the hills, often in very steep and precipitous places, for both they and their animals are expert climbers; and just as the sun is setting they arrive back at the village. Each boy brings home a small load of firewood on his back, and often he carries home a young lamb or goat that has become overtired. And this time one boy usually follows the animals to urge on the stragglers, who might otherwise get too far behind and fall a prey to prowling leopards.

In summer, as soon as the snows have melted, all the sheep and goats are taken up to the alpine pastures above the timber line. There they stay for three months or so, till the first autumn snow falls. Two or three men usually take all the sheep and goats of a whole village,

and as there is a fair amount of rain in the monsoon months they cannot have too pleasant a time. They often construct for themselves small shelters of rocks, if there are no small caves or overhanging rocks to form a protection during the night. Supplies of food are brought to them once a week or once a fortnight from their village. With them there are usually two or three sheep dogs.

The sheep dogs are large and ferocious animals of a local breed, with massive chests and necks, but often with somewhat slighter hind quarters. They are not kept so much for the management of the sheep and goats as for the special purpose of protecting them from leopards. A leopard naturally makes for the neck of his opponent, and the dogs are therefore provided with wide iron collars, the edges of which are turned up to form large spikes, while another row of spikes runs round the middle of the collar. One dog will keep a leopard larger than himself at bay, and two dogs will together kill a leopard. It is said that two dogs in one village of Jaunsar-Bawar have killed nine leopards between them.

The dogs are gentle towards their masters, although sometimes they are not treated very kindly. On the other hand they are very ferocious towards strangers, and although I have only very occasionally known a dog to attack a man, even the local villagers always approach a strange dog with the greatest caution.

The villagers' flocks and herds are of extremely poor breeds, especially the cattle. They are good climbers, but are very small and yield very little milk; few cows give more than a seer (about one and a half pints) of milk a day. The cows are kept mainly for the production of plough oxen and for the manure they yield, and little importance is attached to milk producing qualities.

The agricultural work does not occupy the whole time of the people, especially in the uppermost villages which are under snow for several months in winter. The animals need constant attention, but a few men and boys can look after all the flocks and herds of a village. So most of the villagers have a fair amount of spare time, particularly the men, who do not do so much as the women. Part of this spare

LIFE IN A HIMALAYAN VALLEY.

13. Pounding the grain.
Throughout the winter the women and girls have the daily task of pounding the rice and other grain to separate it from the husk. Special holes are made for this in the stone courtyards of the houses.

14. Winnowing the grain.
After being pounded, the grain is shaken in shallow trays, when the husk is blown away by the wind. *Photos by E. C. Mobbs.*

time is spent by those who are skilled enough in the making of clothes, blankets, ropes, shoes and other things from wool and goats' hair, in preparing agricultural implements and in other occupations. But a great deal of time is just wasted in smoking, drinking home-brewed wine, and in gossiping.

Sometimes the people work for the Forest Department, especially in the Tehri-Garhwal State, where they are compelled to assist in works for fire protection at fixed rates of wages. But on the whole the people are lazy and it is very difficult to get them to do any work at all. The people of Jaunsar-Bawar are even worse in this respect than those of Tehri-Garhwal. The reason is, of course, that they have little use for money and they do not see why they should work to get what they don't want. The only requirements from outside are a little salt, a small quantity of cotton material, a little iron and occasionally a few brass pots and vessels. These they obtain from itinerant traders or from neighbouring districts, in exchange for sheep and goats or for surplus grain. Or they may go to the one shop of the district, in the lower part of the Tons Valley, where the various necessities can be purchased for cash.

Money may thus be required occasionally for purchases and is also required for jewellery and for weddings and for the payment of land taxes. But altogether little is required compared with the earning capacity of the people, and they will only work long enough to earn the amount actually required.

The people often complain that they are very poor, especially when they have broken some forest regulation and have to be fined! Yet they will not exert themselves to do much work. Every year large sums of money, amounting to several lakhs of rupees, are spent in the forests by the Forest Department and by the forest contractors who purchase trees standing and extract the timber to the plains. But practically all this money goes to outside labour, which has to be imported at considerable expense from other parts of the Himalayas, such as British Garhwal and the State of Mandi. Even when the local people do work, they are not nearly so good as the outsiders.

They will not work for more than three or four days in succession, after which they go back to their villages for a rest. Great trouble is therefore experienced in getting anything done well with local labour.

The men are so addicted to smoking that they seldom do anything for more than an hour or two without a smoke. And if there are several men together a smoke takes quite a long time, since they smoke in succession, one lot of tobacco sufficing for all of them. One or two leaves from a bush are twisted into a conical receptacle for the tobacco, and this forms the "pipe." In place of matches or tinder box, the men usually have a small piece of rough iron, which is struck on a piece of quartz bearing rock held in some dry moss, which easily catches fire by the spark produced. The leaf "pipe" is passed from hand to hand, each man inhaling the smoke through his hands without letting his lips touch the "pipe." After a few philosophic puffs, the smoker passes the "pipe" to his neighbour, and so it goes round and round.

Sometimes in the pine and fir forests there are no suitable leaves available for the pipe. On such occasions two small holes are made in the ground and are connected by a sort of small tunnel, scooped out with a small piece of wood. The tobacco is placed in one hole and the smoker, lying flat on the ground, places his hand over the other hole and draws up the smoke through the ground and his hand. One by one the men lie flat on the ground and have a few puffs in this way, no man actually touching the ground with his lips.

The simple life of the people is reflected in their customs, thoughts and beliefs. But it is not easy to understand this side of their nature, owing very largely to the inconstancy of the language, which changes almost from village to village. Even a hill man often finds it difficult to understand another man from a village twenty miles or so away. One of my orderlies was a hill man from the centre of Jaunsar-Bawar. It was a little time before I could understand his dialect and he could understand my Hindustani, learnt in the plains. Eventually we got on quite well together, and when I could not understand the local people, he acted as interpreter. But in the uppermost villages

of the Tons Valley conversations required double interpretation. I talked to the orderly, who explained slowly and at great length in the broadest dialect he could adopt to the most intelligent man of the village, who retranslated in his own dialect to the rest of the villagers.

As there are no schools, by far the great majority of the people are quite illiterate and are unable even to sign their names. So the thumb mark is the universal signature for documents of all kinds. Moreover most of the people cannot count beyond twenty. Anything above this number is counted in terms of twenty. Thus a man looking after a flock of two hundred and fifty-three sheep and goats will say that he has twelve twenties, and thirteen. Perhaps they can only count up to twenty because a man has a total of twenty fingers and toes. They do not seem to be able to count in fours by the joints and tips of the fingers, making sixteen to each hand, in the typical Indian fashion. But it is surprising that they cannot count up to thirty, as they have some idea of the Hindu calendar and of months with thirty days. After the twentieth day they begin again, so according to them the fifth day may either be the first-fifth or the second-fifth, *i.e.*, the twenty-fifth. In order to keep account of wages due to them when they work, each day's work is marked by a knot tied in a piece of string made from grass, and by this means a man usually has a fairly accurate idea of the amount due to him.

Their powers of estimating areas and distances are likewise somewhat limited. The size of a small patch of land is usually estimated in terms of the amount of seed required to sow it up, and for small areas the estimates are very accurate. But for larger areas the judgment is frequently very greatly at fault. The people are acquainted with miles, since roads and paths have been measured by the Forest Department and wages for coolies carrying luggage are computed in terms of the number of miles travelled. But once off a measured road, the people have little idea as to how far a mile is. Time is sometimes used as a measure, but a villager's " one hour's walk " may take anything from twenty minutes to two hours. In the upper parts of the Tons Valley distances are always measured in terms of " smokes ." Thus one village may be three smokes from the next

village. This means that in going from the first village to the second the people sit down for a rest and a smoke, three times. A " smoke " is a variable distance, according to the altitude and the nature of the ground, but it is often about two to three miles. Usually in this part there are definite smoking places on the village paths, and sometimes little shelters have been erected as a protection against rain or snow, and sometimes also a little shrine has been erected near by.

All the people seem to have a natural love of flowers, apart from the religious sentiment they attach to certain ones. Saxifrage and other bright flowers are gathered as soon as they come into bloom and are attached to the hats of the men and boys and to the coats of the women and girls as they go along the roads and paths. They are also well acquainted with a large number of wild plants that are useful for food. These include various fungi, particularly Clavaria. the young fronds of certain ferns, and various roots, fruits and leaves of flowering plants. Quite common round some of the villages is the ferocious stinging nettle *Girardinia heterophylla*, which is left severely alone by all browsing animals. But the people have discovered that it is good to eat once the poison is removed. So they collect the leaves with iron tongs, remove the poison by boiling in water, and then fry and eat the leaves as a vegetable.

Many of the people are acquainted with the medicinal uses of certain plants. Flowers, leaves or roots may be boiled to form a tea which is used as a cure for certain ailments. From the fruits, stems or roots of various plants poison is prepared for killing fish in streams, without rendering them unfit for human consumption. The copious brown dry powdery spores of a certain myxomycete fungus is used as a balm for burns and scalds, and certain mosses are used as dressings for cuts and wounds.

The only fruit grown is the apricot, trees of which are usually found scattered in the fields round villages. Their pale pink flowers, frequently contrasting with the dark green leaves and bright red flower clusters of the rhododendron, make the village lands look very beautiful in spring. But the tree is not grown so much for the edible

LIFE IN A HIMALAYAN VALLEY.

15. A hardy man of Kalawa village in the upper part of the Tons Valley.

With no other covering than these clothes, he was sleeping peacefully under a rock on a bitterly cold night.

16. The head man of Osla, the last village up the Tons Valley.

Capable of doing a long day's climbing with any younger man, Bija was an exceptional example of healthy old age.

Photos by E. C. Mobbs.

fruit as for the seeds, which are crushed to yield an oil said to be useful as a cure for rheumatism and also as a spice in food.

But on the whole the ignorance of the people is very distressing. As I have toured about the district, men and sometimes women have come to me for medical treatment for themselves or their children. Whereas a piece of clean moss may be quite good as a temporary dressing for a wound caused by a falling rock or a slip with an axe, I have more usually found that earth has been pulled up with the moss and has filled the wound, making it very difficult to clean. The harmful effect of flies is of course not realised, and the dirtiest of rags usually suffices for the clothing of a sick person. On one occasion a little boy was brought to me with a greatly swollen abdomen. His parents had branded him with red hot irons in their efforts to cure him, and he was in a most pitiful condition when he reached me.

Although the value of medicines and medical treatment is fully realised, the people are mostly very apathetic and in quite serious cases frequently do not think of asking for help till matters have reached an almost hopeless state. On the other hand, when it is learnt that medicines are being given away free, quite healthy people will sometimes complain of internal pains, simply to get medicines to store up against a rainy day. It does not matter much what the medicine is or what the future complaint may be!

Frequently the people seem to take much for granted, but there can be no doubt that they appreciate kindness and help when they are in trouble, and I shall always remember the several occasions when people have come to thank me. One was a boy who had eaten some poisonous fruits. When I was called he was writhing in agony with teeth so tightly clenched that it was only with the aid of several men to hold him down that I could get his mouth open. And before I could do much he was still and declared to be dead. But continued efforts with stimulants and emetics finally brought him round and the following day he came specially to my camp to thank me. On another occasion a little girl was brought to my camp, almost a skeleton, with high fever and extremely weak. It was a slow process pulling

her round and I left before she was completely recovered. But when I went that way again nearly a year later, she came down to my camp with her mother to express gratitude for what I had done and to show how well she had become.

On the whole the people are hardy and one does not see a large amount of disease. Goitre is extremely common, especially in Jaunsar-Bawar, outside the Tons Valley, but it does not often become very serious, and the case of the old woman of Kalawa, shown in the photo, is exceptional. The occurrence of goitre is said by some to be due to the limestone, which is largely present in the outer ranges of Jaunsar-Bawar where goitre is commonest, but only to a small extent in the Tons Valley where the disease is less frequent.

The hardiness of the people has frequently surprised me. On one occasion, when camping near Kalawa village, I heard that bears were doing great damage to the "*madua*" crops in some fields about 3,000 feet below the village. It was autumn and the nights were already very cold and frosty, even down in the fields, so I wrapped myself up with the thickest woollen clothes I possessed. Even so I was only just warm. Imagine my surprise, therefore, when I got down to the fields, to find a middle-aged man sleeping quite peacefully under an overhanging rock, with no covering other than the clothes he was wearing, and they consisted simply of two garments, all holes and tatters. He had had a fire, but it had gone out, and yet when he awoke on my approach, he did not seem at all to mind the cold. He came up to the village the following morning and I took his photo, (Plate 67), from which the extent of his wardrobe can be seen.

As a rule the people do not live to a very great age. They mature quickly and they soon look old and wrinkled, but they usually die before reaching real old age. I suppose that once a man or woman who has passed 35 or 40 gets ill, he or she gives up hope of recovery, which must hasten death. In the uppermost villages life is much more healthy, although harder, and the people live on a higher moral standard. Here old people are more frequently seen than in the villages lower down the valley. The head man of Osla village, the last

LIFE IN A HIMALAYAN VALLEY.

17 and 18. Feeble old age is rarely met in the Tons Valley.

This old man and woman are exceptions to the general rule. They are cared for by their sons and grandsons, but get little more than the barest necessities of life.

Goitre is a common disease in the Himalayas, particularly in Jaunsar-Bawar. But it does not usually assume such serious proportions as with this poor woman.

village before the snow line in the upper reaches of the Tons Valley, was a fine example of a robust old man, quite different from the somewhat dejected looking middle-aged men of the lower villages.

Although the villagers appear so ignorant, they of course have their own views of life and natural phenomena, which they hold tenaciously. I failed miserably in my attempts to explain the cause of the rainbow to the people. They say that a rainbow is a large tube or pipe. The two ends reach down to two valleys, or possibly in cases of small local rainbows to the same valley. The ends dip into the streams and the top of the arc touches the clouds. Water then passes up the rainbow pipe from the streams to the sky. If this is not so, then how does the water ever get to the sky to come down again as rain ?

Again, the ***Praying Mantis*** is quite a common insect, which deposits its eggs on the stems of grass and other plants, and surrounds them with a bright green frothy secretion, which dries to form a brittle mass about half the size of a hen's egg. According to the sages of the Tons Valley, these little egg-like masses are the droppings of the stars ! How do they know ? Well, they have seen them dropping ! What other explanation is there of shooting stars ? The sahib does not believe—but then although he may be very clever, in some things he is very foolish.

(*To be continued*).

A NOTE ON THE HAZARA (N. W. F. P.) WORKING PLANS.

BY H. L. WRIGHT, CONSERVATOR OF FORESTS.

With the exception of the Kagan deodar forests which owing to their steepness are still being worked under the selection system, all the forests in the Hazara District are under plans prescribing modern methods of regeneration fellings with a volume yield. These plans owe their origin to the inspiration of Greswell, who possessed a more intimate knowledge of the forests of this district and a far keener

insight into their silvicultural requirements than any Forest Officer who has served in this province.

Considerable criticism has been directed against these plans in recent years, particularly against that for the Gali forests, where the delay in obtaining regeneration has been held to show that the silvicultural system adopted was unsuited to the forests to which it was applied. But there is not much wrong with the main structure of these plans. Silviculturally they leave little to be desired, and had the intentions of their author been strictly worked up to and management maintained at the high level demanded by the plans, there would have been very little scope for criticising their general principles.

The same cannot be said, however, about the arithmetical side which in every case was based on far too optimistic expectations of the time in which regeneration operations could be completed and an under-estimation of the rotation. These two factors led to an over-calculation of the yield, and, in consequence a too rapid realisation of the growing stock, with the result that the time has arrived when it is difficult to obtain any yield at all from the first periodic block, while the second periodic block will not be fit for felling for some time to come.

This undue optimism was characteristic of all plans prepared from about 1921 to 1925, not only in this province but also in the Punjab and Kashmir, and the mistake was not so much of the author as of those who were then directing working plan policy. Greswell, in every case, emphasised the need for revision immediately a change of conditions or more silvicultural experience made such a course desirable, and had he remained to carry out his plans, there is little doubt that he would have realised the necessity for revision long before the position became acute.

As it was, it was not until October 1931, when the Chief Conservator toured through the Gali forests, that the question of revision came up for consideration. Mr. Trevor then realised that immediate steps were necessary and that unless the yields were revised at once

the position would shortly become critical. He, therefore, re-calculated the yield under each plan, leaving the question of complete revision to a later date. The general principles adopted by him were the same in each case, *viz.*, the omission of all increment from the calculation of the yield, and where necessary, the lengthening of the rotation and consequent extension of the regeneration period. This resulted in a considerable reduction in the yields under all the plans, and these reduced yields were brought into force with effect from the 1st April 1932.

This step was, however, merely a palliative. It postponed, for a few years, the evil day when there will be nothing to come out from the first periodic block as at present constituted, but it did not overcome what is perhaps the main difficulty in these plans, *viz.*, the attainment of complete regeneration and the removal of the entire overwood within a comparatively short regeneration period. For even in the case of chir, where natural regeneration presents little or no difficulty, it is inconceivable, with the experience that has been gained in working these plans, that it will be possible to remove the whole overwood by the end of the first period, even with this extended to 25 years.

Normally it takes approximately half the period to make the first seeding felling over the whole periodic block, and however quickly regeneration comes in, it is unlikely that the later treated compartment will be ready for a final felling by the end of the period. In every case too and with every species there is what may be called the "waiting period," during which the compartment is not in a fit condition to produce regeneration.

This waiting period has not hitherto been taken into consideration, but it is a vital factor, and one which has a most important bearing when assessing the length of the regeneration period. Its length depends on the species being regenerated, soil conditions, and efficiency of working.

Of the three factors which influence the length of the waiting period, efficiency of working is important, for it is one that the forester

is able to control. For if, as has too frequently happened in some of the Hazara forests, main fellings are allowed to carry on for two years and are then followed by three contracts, each lasting for a year, for the conversion of *debris,* and another two years spasmodic work on clearing refuse, then there is a seven years waiting period before either of the other two factors come into operation.

Now if regeneration is to be obtained with the least possible delay, the waiting period must be reduced to a minimum and all operations connected with the regeneration felling must be devoted to that end. In Hazara, where coupes are small, there is no reason why the whole working period should not be reduced to two years, one for the main felling and one for clearing up and burning the refuse.

The other two factors are to some extent inter-related, but the species to be regenerated is a definite factor in so far as distance between seed years is concerned. This is important in the case of deodar as, on an average, at least three years must be accounted in the waiting period for the occurrence of good seed year.

The third factor, soil condition, covers really a large number of factors. It is the one we know little about in these Himalayan forests, but is the one on which further research is likely to lead to the most profitable practical results.

Chir is the only species we can regenerate for itself with any certainty; blue pine and fir are always troublesome, and though deodar usually gives no trouble, most of us have experienced those obstinate compartments where everything seems favourable yet instead of deodar we can get nothing but a profuse growth of some unwanted shrub such as *Parrottia.*

In the Gali blue pine forests the first fellings made under Greswell's plan from 1923 to 1926 were very heavy. Not only were seed bearers left widely spaced, but all hardwoods and even shrubs were cut and removed. Up to the present there is little natural regeneration in these compartments and one reason given for its absence is the excessive opening up of the canopy, and in consequence too great

exposure to the sun and drying up of the soil, so that the seedlings germinate but subsequently dry off. In other words failure is attributed primarily to the light factor.

But if light is the main factor, how is it possible to explain the colonisation of bare hill sides by blue pine which took place all through the Western Himalayas over vast areas some 50 years ago, and which can still be seen taking place over smaller areas even to-day? The Liddar valley in Kashmir and the other side valleys at the head of the Jhelum are typical examples of this colonisation. These, within the memory of living man, were bare grassy hill sides with very scattered blue pine, which, after the introduction of forest conservancy and the stopping of burning, rapidly became covered with young blue pine and now form compact blocks of pole crops. These slopes were hotter and more exposed than any of the regeneration areas in the Galis, yet blue pine was able to establish itself and to survive.

Moreover if it is merely protection from the hot sun that the seedlings require to establish themselves why is it that seedlings are not to be found under the many *Viburnum* and other bushes that are scattered all over the regeneration areas? On the contrary, in the heavily felled areas, the few seedlings there are are all in the open on a clean seed bed and not under bushes.

Everything points, therefore, to soil conditions rather than light conditions being the main cause of the failure to obtain regeneration, and this is borne out by the recent investigation carried out by Mackenzie Taylor on some Kulu forest soils, the results of which were published in the *Indian Forester* for June 1934. This investigation was undertaken with the object of determining differences that might exist in soils on which regeneration and no regeneration of spruce had taken place.

The conclusions arrived at were that the areas on which no regeneration had taken place were characterised by a deep A horizon of high organic matter content, while the areas in which regeneration had taken place were characterised by a shallow A horizon, and it was suggested that the reason for this was that the A horizon has

a high water holding capacity, and as a result of the large amount of unavailable water, the seedlings, which germinate and spend their early life in the A horizon, do not get sufficient water to carry them over the dry period following the melting of the snow.

Assuming these conclusions to be correct, then that portion of the waiting period devoted to soil conditioning is merely the time that is taken to reduce the A horizon to a manageable depth. Left to Nature this soil conditioning is a slow process, particularly under conditions such as are found in the Gali forests, where there are two comparatively long periods of drought. One of the most important lines of research in connection with the natural regeneration of these forests lies, therefore, in discovering a practical method of hastening Nature's efforts to bring the soil to a condition suitable for the regeneration of blue pine.

As far as our knowledge goes at present it appears that the reduction of the A horizon may be influenced by various factors, of which the admission of light, the regulation of grazing, and burning, are the most important.

The admission of light is a factor which plays a part not only in soil conditioning; it definitely influences natural regeneration in other ways. But as a general rule, it may be said that in making the first seeding felling a standard of one crown's space between the crowns of the mother trees is an intensity of opening which satisfies most silvicultural requirements.

Grazing is a matter about which it is impossible either to generalise or to dictate. So much depends on the condition of the compartment at the time the seeding felling is made. Some of the best blue pine regeneration in the Gali forests is to be found in compartments which, owing to rights, cannot be closed to grazing. But while grazing may help in reducing an excessive A horizon, over-grazing, on the other hand, may absolutely inhibit regeneration. One thing is essential, therefore, that the forester has complete control over the grazing in all regeneration areas, but to ascertain the optimum grazing incidence to be allowed will not be easy. It will be a problem to be

solved only by a detailed examination of each regeneration area at each season of the year.

The effects of burning are already well-known, and the immediate success that follows the sowing of patches on which felling debris has been burnt is evidence that no better method could be evolved for bringing the soil to a suitable condition for regeneration, but it is unfortunately a method that cannot be applied to whole compartments. There seems little doubt that it was burning which led to the colonisation of the bare hill sides already referred to. Previous to the advent of forest conservancy these slopes were burnt regularly by the villagers, thus reducing the A horizon to such a shallow depth that when indiscriminate firing was stopped the soil was in a perfect condition for blue pine to germinate and to establish itself.

The best indication of the progress of soil conditioning, apart from the appearance of natural regeneration, is the ground flora. Indicators of a bad condition are strobilanthus, balsam and the dock, which thrive in the A horizon but disappear as it is reduced in depth, giving place to good soil indicators such as the wild strawberry. In the Gali forests strawberry has taken possession over considerable portions of the earlier regeneration areas and over the rest can be seen gradually driving out the dock and the balsam. Where strawberry has appeared regeneration of blue pine is coming in and it seems probable that in five years' time much of the anxiety that has been felt about these areas will have disappeared.

But however successful we may be in evolving methods for curtailing the soil conditioning period, this will always, in all but exceptional compartments, extend to some years, which, added to the number of years that a compartment is under working, will produce a waiting period sufficiently long to merit consideration when assessing the length of the regeneration period. Investigation will be necessary before it will be possible to say, even approximately, what allowance under average conditions should be made for each species, but with our present knowledge it would be safe to assume as the length of the waiting period, three years for chir, five for deodar, eight for blue pine, and anything from ten to fifteen for fir.

Now if this waiting period be accepted, then it follows that allowance must be made for it when revising existing working plans. True the longer the regeneration period the more will the forests take on the appearance of selection forests, but is it altogether desirable to attempt to force these Himalayan forests into perfect uniformity even if it were possible to do so ? For in these forests there are few compartments which are anything like uniform to start with, and to force uniformity leads not only to the sacrifice of much immature material but also to delay in harvesting over-mature and sometimes deteriorating trees.

True most compartments can broadly be allotted to periods, *viz.*, those requiring regeneration (I); those approaching maturity (II); pole crops (III); and those containing much advance growth (IV), but their distribution is never normal and it is always necessary to force compartments into theoretical periodic blocks to which they do not belong.

Everything points, therefore, to a departure from the rigid periodic block I, and to the substitution of something broader, which might be called the "regeneration block," to which would be allotted not only areas requiring regeneration, but also those requiring the removal of the overwood from established advance growth, and a certain number of compartments approaching maturity in which preparatory fellings to induce regeneration could suitably be made. In most cases, it would be unnecessary to force unsuitable compartments into the regeneration block; the main difficulty would be to restrict the area to be allotted.

The area of the compartments allotted to this block divided by the total area of the working circle would give a fraction which, multiplied by the rotation, would give the number of years, *i.e.*, the regeneration period, during which the compartments allotted would have to be regenerated. This would have to be sufficiently long to allow for the waiting period and for the young crop to reach a size sufficient to permit the removal of the whole of the overwood, but within this as a minimum and say half the rotation as a maximum there would be no need definitely to fix the length of the regeneration period.

This is a reversal of present practice, under which the period is fixed first and then sufficient area allotted to fit in with the period ; in this case the allotment is done first and the period is fixed to fit in with the area allotted.

The yield would be calculated either as at present, by dividing the volume of the enumerated growing stock in the regeneration block by the number of years in the period or preferably from an enumeration of the growing stock in the whole working cycle, in which case both the final and intermediate yields would be prescribed by volume.

The advantage of this system is that there should be no hiatus in obtaining the annual yield, for after the first seeding felling had been made over the areas requiring immediate regeneration, and regeneration was being awaited, fellings could be diverted to the removal of overwood in P. B. IV areas and to the gradual opening up of the P. B. II compartments, or regeneration operations could be slowed up from the beginning of the period by spreading fellings over each of these operations from the commencement of the working plan.

Frequent revisions of the plan would be essential, both to enable a thorough review to be made of the progress of regeneration and also to re-calculate the yield. At each revision any compartments fully regenerated would be removed from the regeneration block and new compartments allotted to replace them. Many of the difficulties now being experienced with the Hazara plans are due to revision not having been undertaken soon enough, and it is not too much to say that in no case should the revision of a plan prescribing concentrated regeneration with a volume yield be delayed beyond ten years.

Another essential for the successful execution of plans of this nature is the three years felling programme. This was prescribed under the Kulu working plan as Control Form D, and is used everywhere in Kashmir, but appears never to have been introduced in the Frontier Province. This form makes Divisional Forest Officers think ahead, enables each year's programme to be reviewed three times both by the Divisional Forest Officer and the Conservator, and ensures continuity

of policy even with frequent changes of officers. Without it, regeneration fellings are apt to be looked on merely as the main source of revenue, to be obtained from whatever compartment is most convenient, without considering the silvicultural requirements of the whole regeneration block.

SAL REGENERATION AT RAIGODA, ANGUL DIVISION.

By F. C. Osmaston, Forest Research Officer, B. & O.

This note is written, as it is hoped that the methods adopted to control the large thorny bamboo, *Bambusa arundinacea*, may be of general interest, as may also be perhaps the details of a technique that is proving successful and not too expensive in coaxing sal regeneration to a healthy sapling stage in Angul.

The locality is the Raigoda Block of the Angul Division in Orissa and the work is in the sal areas on a plateau some 1,300 feet above the sea with an annual rainfall of about 65". Hills rising some 800 feet higher surround and indent this plateau which grows sal of good quality (Q. II but never Q. I). The sal forests are intermediate between coastal sal, found in the Puri Division some 100 miles further south on the sea coast, and the moist peninsular sal found in the Singhbhum valleys some 150 miles to the north.

It is a type characterised by the presence of *Bambusa arundinacea* whose immense clumps, often with their 200—300 culms, form an almost pure forest in valleys and along streams to the exclusion of trees except for a few large specimens of *Adina cordifolia, Terminalia tomentosa, Anogeissus latifolia, Mangifera indica, Lagerstroemia parviflora* and *Shorea robusta* which overtop the bamboo in stately grandeur. But as the soil becomes drier the bamboo clumps become thinner, though not necessarily smaller, while tree species are more common and there appears an understory that includes sal regeneration in contrast to the almost clean floor of the purer bamboo crops. In other places bamboos may be absent while on the hill slopes *Bambusa arundinacea* gives place to *Dendrocalamus strictus*

Bambusa arundinacea clump prepared for burning. Raigoda 7, Angul.

Bambusa arundinacea clump being burnt. Raigoda 7. Angul.

Photos by F. C. Osmaston.

which in its turn tends to monopolise the ground. But it is the moister plateau or better quality soil with which this note deals.

In 1923 the Conversion to Uniform System was introduced with a brave optimism that was hardly justified. The regeneration fellings were for the first few years optimistically heavy and the regeneration became swamped by semi-evergreen weeds and annual climbers. Subsequent regeneration fellings were lighter and results were better but it was not until 1930-31 that the present technique and the problem of controlling bamboos was evolved. The current working plan was introduced on the 1st April 1932. It has reintroduced the selection system, but nevertheless the technique (for which considerable credit is due) evolved by Mr. O. A. Dodsworth, the Divisional Forest Officer, and his Range Officer, Maulvi Abdul Sattar and continued by that Range Officer and Mr. C. M. Chaudhuri, the present Divisional Forest Officer, is of interst and it is still successfully followed in the Raigoda regeneration areas.

The procedure is described below. A comparatively light regeneration marking is made. Large trees of species other than sal which are mainly unsaleable are left standing to be girded later. The unsaleable trees are not marked for felling at the same time as the saleable trees, as such a procedure would introduce too much light and encourage climbers and weeds. But the fellings if not too heavy serve to encourage sal and yet prevent its enemies from competing seriously.

One year after the main fellings the clumps of *Bambusa arundinacea* are attacked. This is done in December and January. The smallest clumps, those with about 25 culms or less, are clearfelled and any regrowth is cut back in subsequent cleanings. The larger clumps are burnt standing. The dense thorny branches are cut off to a height of about 4′—6″ and the space thus formed is used for piling firewood obtained from felling debris or, better still, dead bamboo culms. This firewood is stacked inside to a height of about 1′—0″ to 1′—6″. The firewood is then set alight and a fierce fire results that effectively kills the clump. One or two of the outer culms may not be

killed and these are then cut through. The clump remains standing to fall a year or so later when the dead culms rot and collapse under their own weight, doing little or no damage to the sal regeneration that springs up all round. If too much firewood is stacked under the clump the fire is too fierce causing most of the clumps to collapse and fall over then and there. This is not favoured as the culms, heavy with foliage, then tend to flatten the surrounding regeneration. If not overburnt the killed and subsequently leafless and half rotten culms fall individually later on and do little or no damage.

At the same time as the bamboo clumps are burnt, large unwanted, miscellaneous or sal trees are girdled and smaller ones with spreading crowns felled. Climbers are cut, as are also evergreen species choking sal regeneration. This work completes the first year's work after the fellings and is done in the cold weather, at an average cost of Rs. 2/- per acre.

In the succeeding rains a cleaning is made. This consists in cutting all creepers (mainly annuals), cutting back any bamboo regrowth that there may be (usually very little), and also coppicing any competing shrubs or unwanted trees. This work is begun in the middle of August and continues for 6—8 weeks. It is thought that the best time is in early and mid September, but shortage of labour delays work so that it has to be taken up somewhat early and continued late. If done too early the cut annual creepers resprout and are again able to overtop the sal saplings. If done too late these climbers have already topped and flattened the sal leading shoots. The cost of this cleaning on an average works out to about 12 to 16 annas per acre.

This cleaning is repeated in the 3rd and 4th years at a cost of 8 to 12 annas per acre each time, and in most places this finishes the work and the sal regeneration now 5′—12′ high is free and able to hold its own successfully. In some places, however, where creepers are heavy, another cleaning at a cost of about 8 annas per acre may be necessary.

The total cost of coaxing the regeneration through appears to be about Rs. 4/- per acre and should never exceed Rs. 6/8/- even in the

worst areas. The secret lies in the effective method of killing the bamboo clumps and in annual cleaning during the rains. Previously only cold weather cleanings were made, a practice then general throughout the Province. But cold weather cleanings are not of great use as the climbers have been allowed to overtop the sal and preclude its height growth during the rains and only allow growth in the hot weather, growth mainly confined to restraightening the crowns flattened during the previous rains.

In addition, the retention of the larger trees (other than sal) and girdling them after the fellings, is of considerable value. The trees retain shade and so prevent the immediate invasion of weeds and climbers. The subsequent girdling results in delayed death and the gradual thinning of the canopy does not prevent sal from development but it discourages creepers and competing shrubs from reaching their optimum vigour.

It must be understood that this technique only enables previously existing regeneration to develop. There is no evidence to show that fresh sal recruits are induced to appear. In those areas where sal regeneration is absent (mainly where the bamboo is nearly pure, that is to say in the dampest places), sal regeneration is not attempted, but the areas are planted with teak, after a clearfelling and thorough burn. These teak plantations seem likely to be very successful.

It can be easily understood that the technique adopted does not produce a completely even aged crop of sal regeneration. The larger and exploitable sal are removed in the main fellings. Most of the other species are either girdled or felled later, as are the misshapen or diseased smaller sal. But promising sal saplings, poles and trees up to 4 feet girth or even more are probably left. Consequently the regenerated crop contains sal (and other valuable species) varying in age from 0 to say 50 years. To the writer this seems to be advantageous and in no way to be deplored even if the conversion system was being retained. The writer does not believe that an even aged crop of sal is advisable except in localities such as the Singhbhum valleys, where conditions are the optimum for sal growth and regeneration. Even if this idea is wrong the retention of groups of poles and

saplings is wise, (or even isolated saplings or poles if they are not so large as to prevent the possibility of their crowns and those of the regeneration intermingling within say 20 years), since, to do so eliminates largely the waste of poles usually considered unavoidable in a conversion system.

UTILIZATION OF INDIAN ACORNS.

By S. V. Puntambekar and B. S. Varma, Chemical Branch, Forest Research Institute.

Quercus grow all over the hills in northern India and yield acorns in great abundance. No commercial use has been found for them so far and this may primarily be due to their low tannin and oil content. The following extract from "The Industries and Economic Resources of the N.-W. F. Province, by M. A. Rafee" gives some idea of their possible utilization :—

"Two or three varieties of *Quercus* (locally called *cherai*) such as *Quercus ilex*, *Quercus incana*, *Quercus dilatata*, grow in great abundance in the Waziristan hills. The wood is now used as fuel by the people. These trees (the writer has been informed) bear small round fruits (locally called *pergi*) which are rich in vegetable oil. The writer, however, could not personally examine the fruits during the fruit season. Investigations should therefore be made to discover whether these fruits can be expressed commercially to yield oil. If this turns out a success, it will open out a new line of manufacture from which the people of that locality can derive much benefit. These fruits now go waste, whereas they might become a valuable raw material for the extraction of oil, which can be either used for human consumption, if suitable, or be put to other industrial uses, such as soap making, greases, for which purpose such vegetable oils are in great demand in the country."

The oil from *Quercus incana*, *Quercus dilatata* and *Quercus ilex* has been examined (1) and found to consist mainly of the glycerides of palmitic (18 per cent.) and oleic (82 per cent.) acids. As such it

appears to be an edible oil but on account of its low content (16 per cent.) in the acorn kernels (13 per cent. in the acorns) not only is its expression out of question but also its extraction by volatile solvents like petrol, carbon tetrachloride, etc., uneconomical.

The acorn cups (Valonia of trade) have also been examined for their tannin content but the results are not encouraging. For whereas the Greek and the Smyrna acorns which supply the bulk of Valonia yield 30—35 per cent. (maximum 68 per cent.) tannin (2) the N.-W. F. Province species are found to contain 8 per cent. only.

Though the acorns contain an astringent matter, as feeding material they are neither obnoxious nor harmful to cattle and poultry. Some chemists have already reported (3) that " dried acorns make a useful feeding material on account of their high starch content and digestible fibre. Drying the acorns is said to remove a great deal of the astringency which makes fresh acorns impalatable and sometimes injurious to stock. At the same time they contain no substance injurious to poultry. Their food value is equivalent to a mixture of oats and maize. They may replace grain in poultry feed if their slight deficiency in protein is made up." The fruit of holm and cork oaks (*Quercus ilex*, var. ***Ballota*** and *Quercus suber*) and similar species are even used as human food in Spain and Morocco (4).

In order to find whether the Indian acorns could also be used as food material the kernel meal, after extraction of the oil, was further investigated. The results show that it does not contain any substance injurious to the health of animals and indicate that the acorns can serve as a good cattle and poultry feeding stuff provided its protein deficiency is made up by combination with other suitable material of high protein content. It might be mentioned here that the low protein content of Indian acorns will not encourage its use as a source of vegetable casein, the production of which from many non-edible seeds and seed-cakes is already attracting some attention (5) in this country.

Since the acorns (*Quercus incana*) contain considerable quantities of carbohydrates (61 per cent.) they can be of value as a source of

the various products of fermentation. In this respect it is recorded (6) that the English acorns (*Q. robur*) containing 52 per cent. carbohydrates yield 27·5 per cent. alcohol (13 per cent. on nuts as picked).

Of about thirty species which occur in India *Quercus incana* (Vern. Banj) is probably the best known, and therefore its acorn kernels, acorn cups and acorn oil have been investigated in detail. The following tables give the results :—

Acorn Kernels.

Moisture	12·2%
Oil	16·0
Ash	1·4
Proteins	3·0
Cellulose	1·1
Tannins	4·2
Carbohydrates—	
(by difference)	61·8
(by direct determination)	59·5
Sulphur compounds	Nil.

Acorn Cups.

Moisture	12·4
Ash	3·0
Total solids (water extract)	13·3
Tannins	8·7

Acorn Oil.

Consistency	Thin
Colour	Yellow.
Specific gravity at 25° C.	0·9081
Refractive Index at 30° C.	1·4576
Saponification Value	192·2
Iodine value (Hanus)	81·5
Acetyl value	14·8
Hehner value	96·1
Acid value	13·0
Unsaponifiable matter	0·8%
Saturated acids (mostly palmitic)	18·0%
Unsaturated acids (mostly oleic)	82·0%

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REVIEWS.

IDENTIFICATION OF THE TIMBERS OF TEMPERATE NORTH AMERICA (INCLUDING ANATOMY AND CERTAIN PHYSICAL PROPERTIES OF WOOD).

BY S. J. RECORD, M.A., M.F., Sc.D.

(*Published by John Willey & Son. Inc. Price* 18/6*d*.)

As pointed out by the author in the preface, this is a revised edition of his book on "Identification of the economic woods of the United States." The book comprises two parts. Part I deals with both macroscopic and microscopic anatomy, and some physical properties of wood. Part II contains a key to the temperate North American woods and notes and references on their uses.

After giving some preliminary notes on the different anatomical structure of trees of economic importance, the author describes in detail the various types of cells and cell-groups found in wood. These descriptions are supplemented with good photo-micrographs or drawings. To a beginner this book will be a great help in the study of wood anatomy. Moreover the terminology used in this book is the latest approved by the International Association of wood anatomists.

This part of the book also contains 16 tables. Some of these tables give lists of families or genera or species which are characterized by certain important anatomical structure. As far as these tables go, they will be useful for the present for the identification of timbers, but certain alterations and additions will be necessary as knowledge is acquired on the anatomical structure of those timbers which are little known at present.

The key is well planned and appears to be easy to follow. It is based on both macroscopic and microscopic anatomy of the North American woods and will, therefore, be useful both in the field and in the laboratory.

References contain a list of publications on wood anatomy in general and wood using industries of United States of America in particular. The first list does not appear to be exhaustive, for many recent important publications have been overlooked. At the end of the book, five plates containing six photomicrographs (50X) in each are given. These will be helpful in the identification of woods in the laboratory but not in the field. As the key has been based on both macroscopic and microscopic structure of wood, it would have been more appropriate to give both low and high power photomicrographs of some of the important timbers included in the book.

On the whole the book has been well printed and the reproduction of the photomicrographs is good. As it contains the latest terminology approved by the International Association of Wood Anatomists, it will serve as a book of reference for all wood anatomists. Professor Record is to be congratulated for having published this book within such a short time after the approval of the standard terminology by the International Association of Wood Anatomists and making it available to all workers in the field of wood anatomy.

K. A. C.

THE LANTANA SEED-FLY IN INDIA.

It is well-known that the spread of lantana (*Lantana aculeata* L. = *camara* L.) in Hawaii was reported to have been effectively checked by the introduction of certain selected species of the 400 or so insects known to attack lantana in its native home, Mexico. One of these species, *Agromyza lantanae* Frogg., the seed-fly, was stated to have so successfully established itself in Hawaii "that it is now difficult to find lantana plants with healthy seeds" (*Hawaiian Forester* 6 (8) 1909). The Mysore Department of Agriculture made several attempts to introduce the fly into India but the long journey from Hawaii proved too much for the insects, only a few surviving flies from one attempt (1921) being liberated under unfavourable conditions in Bangalore. Subsequent careful search in Bangalore, and an extensive survey of lantana insects in India and Burma by an officer especially employed on the problem, failed to show the presence of the fly.

In an interesting paper,* T. V. Subramaniam (Offg. Entomologist, Mysore State, Bangalore) now gives us the surprising information that he has found seeds infected by this fly not only in Bangalore but in places as widely separated as Travancore, Bombay, Saharanpur and Maymyo. Samples from various places in Mysore showed an infestation of from 2 to 5 per cent. of the seeds; no parasites were reared. There appears to be some doubt as to whether the fly really affects the viability of the seed and Mr. Subramaniam is investigating this important point.

The writer of the paper thinks it unlikely that the flies now found are descended from the few introduced from Hawaii but more probably that the species has been present in India for a long time, perhaps ever since the introduction of lantana into India. There is, I think, at least a bare possibility that the fly is truly indigenous to India and may occur perhaps in the native *Lantana indica* or even in other Verbenaceous plants; if so, it would probably be less efficacious owing to existing checks such as parasites, (one advantage of the deliberate

* The Lantana Seed-fly in India, Ind. Journal Agric. Science **4**: 468—470, 1 pl., 1934.

introduction of a foreign insect species is that its native parasites can be left behind). It will be interesting to discover if infestation remains at the low rate of 2 to 5 per cent. or whether it is found to increase in time. In any case it appears desirable to test whether the insect can attack other Verbenaceae (so important in India but not in Hawaii) both under normal conditions or under "starvation" conditions such as might occur if the insect proved to be a wholesale success in destroying lantana seed. An experiment described by Professor MacBride (*Nature*. April 21st, 1934) is of interest in this connexion. A stick insect (*Carausius morosus*) feeds normally on privet, but a percentage of the insects will accept ivy for food when given no choice; the percentage of insects accepting ivy increases strongly from generation to generation in descendants from the original ivy-fed stock, showing the inheritance of an acquired habit.

Mr. Subramaniam points out that his main object in preparing his paper is to bring the information to the notice of those interested in the subject. This applies to many forest officers who will undoubtedly be glad to supply data to Mr. Subramaniam for his further investigations.

It seems unfortunate that such a long period of time elapsed between the date of submission (2nd October 1933) of this brief and important paper and its final publication (June 1934).

J. C. M. GARDNER.

PROPERTIES OF SUGARCANE SOILS OF JAVA.

The book is intrinsically a treatise dealing with some of the important physical, chemical and biological properties of soils. Some of the chapters in this book could easily find a suitable place in any standard text book on soil science.

The opening chapters deal with the geographical conditions of Java, and the processes of soil formation in that country. The next few chapters give an account of some of the important physical properties of the soils, followed by a chapter on the microbiology of soils.

The chapter on fertilizers introduces the idea of base exchange property of soils in fixing soluble manures. Chapter X is devoted to the requirements of the crop with respect to the soil. The book concludes with a chapter on soil research, pointing out the possibilities of soil investigations, based on determinations of physico-chemical properties of the soil. At the end of each chapter a number of references are mentioned for the guidance of those who wish to pursue the subject further.

The book should not only benefit those interested in sugarcane soils, but should also prove helpful to everyone who is generally interested in soil investigations.

DALIP SINGH.

EXTRACTS.

IS TIDINESS A VICE ?

Nearly every rural occupation has at its back a long tradition or custom of practice which has been handed down from generation to generation. This tradition is generally based on experience and sound common sense and it has been a strong buttress against a decline into shoddiness at a time when rising wages have made it necessary to economise labour. Sometimes, however, a traditional technique has outlived the conditions which gave it meaning and it has then become merely a custom—little more than a superstition ; and very frequently traditional ideas have slowed down the useful application of modern machinery and have caused unnecessary delays in the adaptation of new ideas to our needs. Nevertheless, most rural labourers are uncomfortable in their work unless they are conscious of some tradition which they are following in their methods and objects.

In forestry the tradition of generations only covers one side of a modern woodman's work. There is a tradition of felling, coppicing and bark stripping, and of nearly all the operations of converting the grown tree to human use ; but there is not a tradition of nursery work, planting, weeding or thinning. In almost any part of the country you can find old woodmen who know when coppice is well cut ; but if you find an old woodman who knows when a tree has been well planted you may be fairly certain that he has learned it from a highly trained forester on some big estate or has come under the influence of the new school of foresters as represented by the young men trained at the Forest of Dean. We may thus distinguish between those parts of a woodland labourer's work which are connected with felling, in which a strong tradition survives in most parts of the country, and those parts which are connected with planting and cultivation, in which tradition is operative to a very unimportant extent.

Owing to the continuity of human thought a new invention nearly always bears the stamp of custom. The early motor cars were built like horse carriages and it took many years to develop an automobile which was entirely divorced from the traditions of horse traction. In the same way the early forest cultivators, having no forest tradition to apply, worked on the principles of cultivation in other fields. They had experience of farming and gardening, and they naturally applied the same ideas to forestry as had ruled their action in these occupations. In other words, just as the early motor cars carried on the tradition of horse-drawn vehicles, so the early silviculturists carried on the traditions of farming. In the motor industry very active minded and enterprising men are engaged and competition and big demand make for swift changes, so that in a few years the vestigial remains of the horse carriage have disappeared from the motor car. But foresters move more slowly and it appears to some of us that not only is the agricultural tradition still very strong in our forest practice but that many of the traditional applications of agriculture are definitely harmful and should be discarded.

These farming traditions are mostly associated with tidiness, the desire to " have things ship-shape." And every good landowner likes to have his fields tidy. But cultivation in woods is very different from cultivation in fields and the needs of trees are very different from the needs of farm crops. And it seems likely that in certain respects the desire for tidiness in woods has led to practices which are definitely harmful.

The clearest case in which tidiness is a vice is the removal of woody litter from the forest floor. When young plantations are brushed up or when thinnings are cut a lot of untidy litter is left on the ground. Through excess of zeal the woodmen on some estates carry this litter to the edge of the plantations and burn it. The soil is thereby deprived of its most valuable mulch ; for mouldering wood is a very useful manure.

There are two dangers which may be incurred by leaving the litter. One is that the fire hazard is increased : the other that insects or fungi may find breeding grounds for their propagation. But most modern foresters carry the litter further into the plantation from any dangerous edge, away from occasional sparks or cigarette ends. And the danger of infection of insects and fungi being spread is negligible from small branches and tops. Any pieces less than two inches in diameter rot too quickly to harbour pests.

When area is to be planted after clear felling, the top and lop of the previous crop is usually burnt, otherwise it is difficult to get in the plants or to destroy rabbits. But this burning is generally done much too thoroughly. Where litter remains the soil is definitely protected ; to see this we have only to compare the hard parched surface of an area, which has been " efficiently " cleaned and then exposed to the sun, with the moist, soft open surface of an area which is covered by a heap of sticks. Heaps of wood also provide shelter for the young plants from wind and frost and give them a much better chance of establishing themselves. And yet many woodmen are so keen on having their planting grounds as clean and tidy as a newly

ploughed field that they take an especial pride in collecting every stray stick to put on the fire.

When farmers and gardeners plough or dig land, they like to leave it rough through the winter so that it will crumble with the frost, and they till or hoe the surface to keep a loose mulch when the sun gets hot. Foresters cannot do this and they have to think of other ways in which to keep their land in good heart. Nothing helps more than a layer of sticks; but if much litter is left planting is troublesome. We have here to balance costs in our minds, and remember that it often costs £4 to burn an acre of top and lop and that if we did not burn we should have this additional amount to spend on planting. We might experiment in an attempt to halve the cost of burning and spend the money which is saved on getting the trees established among the remaining brush.

The woodman with a flair for tidiness has his next chance in the actual planting, and he will show you with pride spacing which is judged with such exactitude that not only are the lines straight in themselves but the trees can be sighted in cross lines, and even diagonals, in strict regimental order. In farming straight ploughing and straight drilling may be an economy, and the skilled ploughman will plough a straight furrow more rapidly than he would a crooked one. But when these ideas are applied to forestry they become extravagant nonsense, and all that a practical forester requires is that the lines should be sufficiently straight to enable the men to find the plants when weeding. As pointed out by Mr. Ackers it is much better when planting among coppice stools to place the trees far enough from the stools to prevent their being immediately overshadowed and to allow room for a coppice shoot which may be useful. On the other hand it often pays to plant a tree close up against the dead stump of a felled tree, as it derives protection and nourishment from the mouldering wood.

It is not only in clearing the ground and in planting that the lover of tidiness can have his fling. He can do still more damage when he comes to weed the planted land. If a well-regimented plantation is beaten up and weeded with meticulous care a planter's paradise may be attained. Every tree will be in its correct place, and a pure larch plantation will be really pure, without a weed to be seen. Mr. Ackers' woods are not like that. There are as many natural seedlings and coppice shoots as there are planted trees, and it is often difficult to discern whether the plantations are intended to be pure or mixed. In such woods many conventional foresters are shocked at what they regard as the awful consequences of neglect. But let us sum up the pros and cons before condemning them.

First, there is no doubt that such a wood preserves the soil in better heart. The intrusive "weeds" help to cover the ground from the earliest age, and their fallen leaves give a mixed litter which is the best mulch. Also, by allowing self-comers to grow, time and money are saved in beating up and weeding. On the other hand, these shoots generally take the place of the early thinnings, and in larch plantations though not in other species, there may be some loss in the returns from bean sticks and rustic poles. On estates where there is a very small area of plantations and

every larch pole is cherished, this will be a serious objection, but where there are extensive plantations the individual thinnings are less esteemed as it is difficult to dispose of a large number of small stems.

It is, perhaps, unfortunate that foresters should have taken over the word "weed" from farmers. The word suggests that all but the planted trees should be destroyed, and this is another agricultural tradition which foresters are very slowly growing out of it. The modern ecological view that a wood is a complex system in which the trees, shrubs, ground vegetation and the soil fauna and flora combine to preserve a healthy and stable condition leaves very little use for the word "weed." That some plants are a nuisance all foresters will agree, and if we confine the word "weed" to such pests as elder, which no cultivator wants to see, the change of verbal usage might encourage a change in woodland practice.

It cannot be maintained that all "weeding" is harmful. Even if the object of our planting is not to produce a pure plantation, we nevertheless expect that our planted trees will produce the dominant crop, and at maturity it is probable that most self-comers will have been excluded. What we hope is that in the meantime the natural growth will have helped to clean the planted trees and preserve the soil, and it is for this reason that we should spare as much as we can.

Forest practice will always vary from place to place. Some soils need protection from the sun so greatly that weeds and woody litter should be preserved even if it involves more expenditure, while others may benefit from insolation which encourages the decomposition of dead leaves which are all too durable. In some districts, too, there are markets for "weed" species which would remain unsold elsewhere. So it is dangerous to criticise a forester in these matters until we know the conditions under which he is working. But, in any case, it is unenterprising for forestry to retain the traditions of agriculture when their application serves no useful purpose.

(*Quarterly Journal of Forestry, No.* 3, *Vol. XXVIII, July* 1934,)

PRESERVATION OF WILD LIFE IN INDIA.

No. 4.—THE UNITED PROVINCES.

By

F. W. Champion, I.F.S.

(Deputy Conservator of Forests, United Provinces.)

One among the numerous striking results of the Great War has been an awakening all over the world to the fact that wild animals are tending to become less and less in numbers in many countries, and often species that were common a few decades ago are being, or actually have been, entirely exterminated. Most of us who went through the War saw far too much of killing ever to want to see any more, and the natural reaction has been that a new spirit of sympathy with wild creatures has become firmly established in many countries. Wild life protection societies are springing up here and there, particularly in America and England, and the society for the Protection of the Fauna of the Empire is doing great work in trying to pre-

serve the wonderful fauna of the British Empire from further wanton destruction. An enthusiastic branch of this society has been started in India and very good work is being done, but unfortunately it is not receiving so much support from Indians as could be desired. Indians, many of whom are prohibited by their religion from taking life, should be the very first to support such a society and a number are already whole-heartedly doing so, but real mass support has yet to be received. This I believe to be very largely due to lack of knowledge of the aims and objects of such a society, and insufficient propaganda, and I am confident that much greater support will be received in future as a result of the great efforts now being made by the Bombay Natural History Society and the various local branches of the Society for the Preservation of the Fauna of the Empire, which all who have the slightest interest in wild animals should join without a day's further delay.—After all, once a species of wild animal has been exterminated, no money, no society, no human agency can bring that species back to the world, and delay in helping those who are doing their best to save species already threatened with extermination may mean that help, tardily given, is given too late.

Position of Wild Life.

The present position in the United Provinces is, perhaps, not quite so bad as in some other parts of India, owing to the presence of a very sympathetic government, an influential Forest Department, and great land-holders, all of whom have always remembered that, within limits, wild creatures have just as much right to exist as the human race. The position inside reserved forests and in certain large estates, which is fairly satisfactory, will be discussed later in this article, but first the present state of affairs in the ordinary districts will be considered. It is the conditions in these ordinary districts, composing 80 per cent. or more of the whole Province, which are causing so much worry to those who are interested in wild life. Frankly the position is appalling. The vast increase in gun-licenses which has taken place within recent years, combined with the greatly improved means of transport, has caused a drain on the wild life of the districts such as can end only in the almost complete destruction of any kind of wild creature considered to be worth powder and shot. Laws do exist imposing close seasons, but these laws often are not, and cannot be, observed in present-day conditions. Deputy Commissioners and Superintendents of Police in some cases do their utmost, but they are so over worked nowadays with political and economical troubles that, however keen they may be, they literally have neither the time nor the energy to try to enforce unpopular laws, which, by comparison with present day troubles, possibly do not seem very important. Further the responsible officers in a district are very few in number and it is quite impossible for them to stop bribery among their often low-paid subordinates. A rupee or two or a piece of meat is quite sufficient temptation to an underpaid chowkidar not to report an offence under a Wild Animals' Protection Act, particularly as it is often extremely difficult to prove such an offence, and, even if proved, a subordinate magistrate will generally let off the offender with a purely nominal fine. It therefore seems that, in the present state of the country, any Act enforcing close seasons outside Reserved

Forests, however well it may be conceived, is worth little more than the paper on which it is written. In actual fact special efforts are now being made in Hamirpur and Meerut districts to protect sambar and chital, but it is not known to the writer how far such efforts are proving successful. Animals like black-buck and chital and game-birds, both in the plains and particularly the hills, are literally being wiped out at an increasingly rapid rate and one wonders if there will be anything left except monkeys and jackals after another two or three decades. There is one bright spot, however, and that is that non-game birds at least are not harried to the same extent as in England because the egg-collector is scarce, and the average Indian boy, unlike his English confrere, does not amuse himself by collecting vast numbers of birds' eggs, only to throw them away in most cases as soon as the boy begins to grow up. Taken as a whole there is no doubt whatever but that the position in these plains districts of the United Provinces is just about as bad as it could be, but one must always remember that these areas are very densely populated and that really there is not very much room for any considerable numbers of the larger game animals, which must tend to interfere with the cultivator and his crops. In any case leopards are found in many places, since they are prolific breeders and very difficult to keep in check, and, even if more adequate protection were given to the game animals in cultivated districts, it is probable that their numbers would still be kept down by a corresponding increase in the numbers of leopards.

Sufficient has now been written to show that the position in the cultivated districts is very unsatisfactory, but that increasing population in already heavily populated areas, combined with the present political and economic distress, makes it very difficult to make practical suggestions for improving matters. What can be done is for large land-holders in sparsely populated districts to preserve restricted areas really efficiently, and noble examples of what a great help to the wild life of a country such measures can prove to be is to be found in the great swamp-deer preserves of Oudh, notably those of the Maharani Saheba of Singahi and of Captain Lionel Hearsey. The former of these has been under careful protection for many years and an area of perhaps 20 square miles now contains several thousand head of these magnificent deer. A few are shot annually, but the number destroyed is almost certainly less than the natural increase, and these public-spirited benefactors can justifiably feel that, so long as they maintain their present standard of efficient preservation, there is no fear of the swamp-deer following the already long list of fine animals which have been exterminated from the United Provinces.

RESERVED FORESTS.

Now the position of wild animals in the Reserved Forests, of which the writer, being a Forest Officer, has perhaps a specialised knowledge, will be considered. Firstly the writer would state most emphatically that United Provinces forest officers as a class are, and always have been, extremely sympathetic towards wild animals. Few are really heavy killers and quite a number do not shoot animals at all, beyond their requirements for food for themselves or their camp followers. An odd individual here and there, both in the present day and in the past, has possibly let his sporting

instincts drive him into becoming a really heavy killer, but the amount of slaughter done by the average forest officer in these Provinces is conspicuously small. It sometimes happens that disgruntled sportsmen state that Forest Officers are selfish or destroy more animals than all other classes put together ; but these statements are most emphatically untrue and generally have an inner history, which reveals the accuser as having some personal grudge against an individual Forest Officer, which leads him to make general insinuations which are totally unfounded. None could be keener on the preservation of wild life than the present writer, and, if he thought that his brother officers were indifferent to the preservation of wild animals, he would not hesitate to say so. The writer believes that it would be great mistake to remove the wild animals inside Reserved Forests from the protection of the Forest Department and place them in charge of a separate Game Department. The present system is working very well and such action would be regarded as a slur on Forest Officers and would alienate the all-important sympathy of the powerful Forest Department.

The United Provinces reserved forests are not very extensive and they are all under the personal supervision of divisional forest officers. Poaching does occur to a limited extent, particularly during the monsoon when the forests have to be desertedowing to their unhealthiness, and from motor cars, but such poaching is not very extensive and every effort is made to keep it in check. Elaborate rules, which are constantly being amended, do exist for the issue for shooting licenses, for the enforcement of close seasons, and for helping any species which is tending to become scarce. These rules may not be perfect—no rules ever are—but at least their object is to provide shooting for all who apply in the right way, and at the same time to preserve the wild animals in perpetuity without letting them increase to such an extent as to become a nuisance to forest management or to surrounding villagers. Species that, for any particular reason, need help are entirely protected, examples being wild elephants for many years and sambar in Lansdowne division since an attack of rinderpest in 1927 ; and senior forest officers are always ready to listen sympathetically to applications for protecting particular animals in particular tracts. Even tigers now have a close season and are not allowed to be shot by artificial light. Some may argue that it is a wrong policy to protect tigers, but at least such protection shows that forest officers consider that even tigers have the right to live in their own jungles.

On the other hand some wild animals, such as deer, do seriously interfere with the management and revenue of valuable forests, and the forest officer cannot allow deer to increase to an excessive extent. In some cases, particularly where the balance of nature has been upset by the excessive destruction of carnivora, deer have become a positive pest, and it has proved necessary to reduce their numbers. Or again, the proportion of hinds may have become excessive, with consequent deterioration in the size of the stags, so that some of the hinds have had to be shot off ; but such destruction is stopped as soon as the position becomes normal once again. It is true that individual forest officers, keen silviculturists who have found all their

efforts at improving the forests ruined, have occasionally advocated the total destruction of deer: but it is not the general opinion that such drastic measures are required and interesting experiments are now in progress by which considerable areas, in which plantations or efforts at obtaining natural regeneration of valuable trees are in progress, are entirely closed with game-proof fencing, which keeps out the deer. Such fences are somewhat expensive in initial cost, but they can be moved from place to place as required and are probably the best solution for managing forests both in the interest of the forester and also of the indigenous wild life.

It is sometimes stated that, even in the reserved forests, wild animals are much scarcer than they used to be. The writer cannot speak for 30 or 40 years ago since the old records are not clear and he was not in India at that time; but, even if the head of game had diminished, it is possible that the numbers were excessive in the past or that the memories of those who claim that animals are disappearing are a little at fault. After all, most of us tend to think of the 'good old time,' although it is possible that those times were not quite so good as they now appear in perspective. An effort has been made to collect figures of animals shot in the past with those shot nowadays for comparison, but records of 30 or 40 years ago do not give the information required. The following are the conclusions that the writer draws from the figures that are available:—

(*a*) Taken as a whole the head of game shot recently has generally not shown any marked decrease, except in the mountain reserved forests, where control is not so easy.

(*b*) Tigers appear to have increased and marked decreases seem to have taken place in the numbers of nilgai, kakar, wild-dog and black-buck. The decreases are partly due to serious floods and rinderpest epidemics, and are probably natural fluctuations which will right themselves in time. Wild-dogs have decreased owing to the large reward paid for their destruction.

(*c*) The decreases in the number of some animals shot recently are due to the removal of rewards as a measure of economy.

(*d*) It must always be remembered, however, that the number of animals inside Reserved Forests is probably being artificially swelled by the influx of refugees from the appalling conditions at present prevailing outside. This influx will decrease as animals outside become exterminated. Also modern rifles are so good and shooting with the help of a motor-car is so easy, that probably a greater proportion of the existing animal population is shot annually nowadays than was the case in the past.

(*e*) The Forest Department watches these lists carefully and takes action whenever such action appears to be required.

(*f*) The general impression of senior forest officers is that, although there have been considerable fluctuations in particular areas, the game in United Provinces Reserved Forests as a whole has not markedly decreased during the last 25 years except in the high hill forests.

To summarise, the present position of wild animals inside the Reserved Forests of the plains and foot-hills of the United Provinces does not give cause for serious anxiety, except for the ever-increasing use of that arch enemy of the wild animal—

the motor car. The numbers of wild animals in the mountain reserved forests appears definitely to be decreasing. The position in some zemindari estates is good and in others poorer; and the position in the ordinary district is almost hopeless.

SOME SUGGESTIONS.

The writer would make the following suggestions to help the present state of affairs :—

(*a*) *Public opinion.*—This is by far the most important of all methods of wild life conservation, and, without it, all efforts to preserve wild creatures will prove abortive. Good work is already being done by propaganda and by lectures, but much more remains to be done. Good illustrated books help greatly and the formation of sanctuaries and national parks, where the general public can see wild animals in their natural state, would all help. Major Corbett as local Secretary of the United Provinces branch of the Preservation of the Fauna of the Empire Society is doing a lot to assist in this work.

(*b*) *Laws.*—It is much easier in the present state of India to pass a law than to see it enforced, but the writer would greatly like to see laws passed on the following points :—

(1) *Sale of shikar meat, trophies, etc.*—It is of vital importance that a law be passed at an early date totally forbidding the sale of any portion of a wild animal, with certain definite exceptions. Such exceptions would be the dropped horns of deer and the hides of deer where number have to be reduced. Special licenses should be issued in such cases and such licenses, liable to cancellation at any moment, should be under the personal control of the Divisional Forest Officers, where reserved forests are anywhere near, or under Deputy Commissioners where there are no forest officers. The sale of any shikar trophy should be entirely and absolutely prohibited. Such a law, properly enforced, would finish the professional poacher, and would end the nefarious dealings of certain taxidermists who sell shikar trophies to those 'sportsmen' who are incapable of bagging anything themselves.

(2) *Limitation of gun licenses.*—This is very difficult in the present political state of the country, but at least greater efforts could be made to differentiate between game licenses and licenses for the protection of the crops, person, property or display. Gun licenses for the protection of crops should insist that barrels should be sawn-off short, as such licenses are very largely applied for when the real object is poaching.

(3) *Motor cars (and also carts and tongas).*—The shooting of any wild animal from or within, say, 400 yards of a motor-car cart or tonga, either by day or by night, should be made an offence liable to prosecution. The writer personally would like to stop motor cars altogether from entering Reserved Forests, or, where this cannot be done, he would like to place check-chowkies at the entrances and exits of such roads, the cost to be covered by a small wheel-tax. Firearms would either have to be deposited at such chowkies or would be sealed, so that they could not be used while inside the forests. The excuse of requiring firearms for protection en route should not be accepted, as passengers in motor-cars very rarely need protection from wild

animals, except possibly from occasional rogue elephants or man-eaters. Luckily recent economies have resulted in the abandoning of some of the motor-roads in the Reserved Forests of the United Provinces. The writer would like to see them all abandoned! The old time shikari or forest officer managed perfectly well without them, and they tend only too often to make his modern successor slap-dash and lazy.

(4) *Protection of rare stragglers.*—It occasionally happens that a rare animal, such as a rhinoceros, strays into Reserved Forests from Nepal or elsewhere. Such animals should be rigidly protected with a fine of, say, Rs. 2,000, or imprisonment, for their destruction. The excuse that 'if I don't shoot it, someone else will,' should never be accepted in such cases. The recent law passed in Bengal for the protection of the rhinoceros should be extended to the whole of India.

(5) *Rewards.*—The writer considers that Government rewards for destroying wild animals should be given far more sparingly than in the past. Luckily recent economies have resulted in a great reduction in the rewards offered, and it is sincerely to be hoped that such reduction will be permanent. Rewards in the past have encouraged poachers and have sometimes caused an upset in the balance of nature where they were misapplied. They are really quite unnecessary except for man-eaters and notoriously destructive creatures such as porcupines.

It has been suggested that details of breeding-seasons of various animals should be appended to this article. Inside Reserved Forests every effort is made to protect wild creatures during their breeding seasons and nothing more can be done. Outside Reserved Forests, as already explained in this article, the position is such that protection can very doubtfully be enforced. Hence such an addition to an article which is already too long seems unnecessary, but the writer can supply a list of breeding seasons, so far as they are known, to anyone who is specially interested in the matter.

Since writing the above I have been reconsidering this question and have read up a certain amount of literature on the subject. On the whole I have little to add to what I wrote before except that I am not so certain as I was that the head of game inside the United Provinces reserved forests is not decreasing. I was posted to N. Kheri division in 1921 and I returned there again in 1931. Although still a good place for animals in 1931, I would estimate that there had been at least a 25 per cent. decrease in nearly all species during that decade. The reasons for this reduction I would put down to (*a*) motor-cars making shooting far easier than it used to be, (*b*) the destruction of game in the adjoining areas outside the forests resulting in a smaller influx and greater damage to animals straying outside.

I am now in Bahraich division in Oudh, which has a reputation of being a good game division. I have now been here for five months and, so far, I have found game of all kinds to be rather scarce, although I hear that more animals come in from Nepal in the hot weather. The reasons for this apparent decrease are the same as in Kheri, *i.e.*, motor-cars and destruction of animals outside the forests, combined with increased poaching along and near the Nepal border.

I have recently heard from Col. A. E. Wood, I.M.S., a keen supporter of the Darjeeling Natural History Society, that in his earlier days Lachiwala in Dehra Dun

division used to be a 'veritable paradise' for wild animals. I am well acquainted with Lachiwala and I can only say that it is very far from being an animal paradise nowadays. It is more a 'paradise' for motor-picnicers from Dehra Dun City and Cantonment.

On the whole I am afraid that there is a distinct doubt that the game inside the reserved forests—particularly in Oudh, where motors now penetrate to every corner—is so plentiful as it was, although the present position does not give rise to the same anxiety as is the case with other areas not under the control of the Forest Department.

(*Journal of the Bombay Natural History Society, Vol. XXXVII, No.* 1 *of April* 1934.)

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*ANNUAL REPORT OF FOREST RESEARCH BRANCH, F. M. STATES, 1933.

I.—Forest Survey and Exploration.

1. An area of 2,400 acres of hill forest in the Bubu reserve was explored by the students of the vernacular school under the superintendence of the Instructor, Mr. D. B. Arnot. Mr. H. E. Desch, Wood Technologist, and Mr. F. H. Landon, Assistant Conservator of Forests, were attached to the party for local training.

2. The enumeration was conducted on more intensive lines than hitherto, both as regards the composition of the crop and the possibility of commercial exploitation. Particular attention was paid to lines of communication and potential extraction facilities, and enumerations were summarised for each 10 chains of *rentis*, so that it was possible to obtain a clear idea of the stand of timber in different parts of the area and to distinguish between accessible and inaccessible sources of supply. This is considered to be a great advance on the earlier enumerations, which did not aim beyond averages for the entire area and were, for that reason, only useful as a general guide to reservation.

3. The Forest Botanist accompanied the school on the trip referred to above. He also paid short visits to other localities mentioned in the botanical section of this report.

II.—SILVICULTURE.

(*a*)—Sample-plots.

4. Five new plots were established in Perak South, *viz.*, three in pole stands of practically pure *meranti*—chiefly *meranti tembaga* in the Parit reserve, for the purpose of ascertaining the effect of different degrees of thinning; and two in the Bikam reserve, where the old *chengal* nurseries were freed from domination and thinned with the object of forming pure stands for future volume determinations. No new plots were formed in any of the other divisions. Annual measurements of existing plots were continued.

(*b*)—Treatment Plots.

5. The felling and girdling plots in the Sungai Buloh reserve were replicated. Owing to the need for economy these operations were limited to the first two of the series, *i.e.*, canopy manipulations of increasing intensity brought about by fellings

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* Federated Malay States—Report on Forest Administration for the year 1933,

and girdlings in successive storeys, as described on page 55 of the Report for 1931. The efficacy of the different kinds of treatment in the earlier plots cannot be compared until a general cleaning is undertaken. The first of the 1931 plots will be cleaned in 1934.

(*c*).—PLANTATIONS AND NURSERY.

6. Planting operations were confined to the supplying of blanks in the more promising plantations, dissimilar species being used to avoid confusing the records of the original plantings. From observations of growth of seedlings planted under different conditions of exposure it can now be stated with some confidence that planting in lines in high forest is a waste of money. None of the species under observation has thrived under such conditions, and even where survival has been adequate the casualties due to the removal of the overcrop are far too heavy to be made good by the survivors. A number of plantations formed under such conditions has, therefore, been abandoned. There can be little doubt that the most favourable planting conditions are provided by old *belukar*, which provides the necessary cover and which can be removed without damage when the young crop has established itself. Planting of high forest forms in *lalang* is foredoomed to failure in the absence of of species that can resist this weed, such as *leban*, *batai* and *tembusu* (*Fagraea fragrans* Roxb.). The total planted area is now approximately 300 acres.

7. The 10-acre plantation at Sungai Buloh was cleaned and found to have a satisfactory survival percentage. Some of the *yemane* were 15 feet high in as many months after planting and 18 months from seed. The other species are, of course, much less spectacular, but have done well.

8. The growth of specimen dipterocarps in the arboretum area has been very satisfactory ; the non-dipterocarps do not show the same promise, and the area devoted to them has therefore been planted up with *tembusu* in the hope that this will induce more suitable growing conditions. This section of the arboretum is undoubtedly inferior as regards soil.

9. About 13 acres of vegetable gardens were planted with *yemane* stumps on the understanding that the cultivators will be given land elsewhere when the trees interfere with their crops. The experiment promises well.

10. The upkeep of the field in front of the Institute, which was in process of conversion into an ornamental area, has had to be discontinued for reasons of economy. For the same reason some of the paths have had to be abandoned or cleared much less frequently than formerly, but the main paths have been satisfactorily maintained.

(*d*).—PHENOLOGY.

11. Reports from the districts indicate that there was no general fruiting of commercial forms, though certain species produced heavy crops in circumscribed localities. *Meranti bukit* fruited freely both at the Gap and near Ringlet, Cameron Highlands. Reports from Pahang and Kedah indicate that *keruing* produced seed in some abundance. *Meranti tembaga* fruited freely in a number of districts, including Kuala Lumpur, but not in the experimental area at Sungai Buloh. It is doubtful whether general records of fruiting are worth continuing, based as they are on casual

observations. A better idea of the periodicity of the different species could probably be obtained by maintaining records of regular observations in conveniently situated areas set aside for the purpose.

III.—BOTANY.

12. One thousand eight hundred and eighty-two herbarium specimens were received throughout the year. These are mainly tree collections made by officers of the department, but include 126 miscellaneous duplicates presented by the Director of the Botanic Gardens, Singapore, 15 dipterocarps from the Conservator of Forests, Sarawak, and 6 Bornean collections from the Oxford University Exploration Club. Important contributions by officers of the department include 88 numbers from Kelantan, 81 from Brunei (both little explored fields) and 137 from Cameron Highlands and Ulu Telom. The Instructor, Forest School, and the Forest Botanist collected fairly extensively in Bubu reserve (Perak) in the early part of the year. This collection included some 60 numbers from Gunong Bubu. The collection of greatest botanical interest made throughout the year was one of over 200 numbers from Gunong Korbu, which includes a number of rare mountain plants and some new species. Interesting botanical collections were also made at Klang Gates, Fraser's Hill and Batu Caves.

13. Routine work included the general upkeep of the herbarium and the identification of new material. The remounting of old herbarium sheets continued throughout the year and is now almost complete. Sheets identified by the Forest Botanist at Kew were laid into the herbarium at the beginning of the year. Assistance in the identification of many miscellaneous collections has been received from Singapore, where Messrs. Holttum, Henderson and Carr have been particularly helpful in the identification of the ferns and bamboos, *Eugenia* and orchids. Special mention should be made of the work on *Ebenaceae* by Mr. Backhuizen van den Brink of Buitenzorg. A systematic revision of the identification of all sheets in the herbarium was started at the beginning of the year and has progressed as far as the *Guttiferae*.

14. Special study includes work on the *Dipterocarpaceae* and on *Cedrela*. A paper on the former was published in the *Gardens Bulletin* in May and another is in the course of preparation. Essential literature loaned by the Director, Botanic Gardens, Singapore, has proved invaluable in this work, as also has the loan of material from the herbariums at Buitenzorg, Calcutta, Dehra Dun, Manila, Maymyo and Singapore. We have also to acknowledge our indebtedness to Kew and to Dr. Burtt Davy of the Imperial Forestry Institute, Oxford.

15. As a basis for research on Cameron Highlands timbers a botanical enumeration of our collections of tree species from this area is being made and is now nearing completion.

16. The identification of sheets authenticating timber collections for the Wood Technologist, the standardisation of vernacular names, and the prospective revision of the timber roll have necessitated a considerable amount of systematic work on miscellaneous problems from time to time.

17. Ecological study has had to give way to more pressing work during the year. Some of the observations made were summarised in a note on " The Study

of Secondary Growth on Rain Forest Sites in Malaya " (*Malayan Forester*, V. II. No. 3, p. 107).

18. The artist has continued seedling drawings as a matter of routine throughout the year. He has also been engaged in the preparation of pen drawings of dipterocarps for the Forest Botanist and has improved considerably in technique. A number of plates has been made of type herbarium specimens received from time to time, and a little field photography has been carried out.

19. Besides the jungle trips to Bubu and Gunong Korbu the Forest Botanist and staff visited Cameron Highlands and reserves in Kuala Kangsar, Tapah and Seremban districts throughout the year, making notes upon the composition of the jungle. The Forest Botanist also spent a few days at Singapore working in the herbarium.

IV.—WOOD TECHNOLOGY.

20. The greater part of the first four months of the year was spent on a course of study of the forest characteristics of the commoner jungle trees under the Instructor, Forest School, which included an enumeration survey of a reserved forest and a tour in Perak, Selangor and Negri Sembilan. Subsequently the activities of the Wood Technologist were mainly devoted to completing the formation of a reference collection of microscopic slides of all local timbers, backed by authenticated wood specimens cross referenced with botanical material in the herbarium. By the end of the year a collection of 1,759 wood specimens representing 62 families, 233 genera, and 626 species had been labelled and arranged. Some 1,400 of these were sectioned, five slides of each being prepared, two for retention at Kepong, and one each for distribution to the Imperial Forestry Institute, Oxford, Princes Risborough and Yale University in exchange for material and publications received from those Institutions. Arrangements were made with these bodies for the supply of slides in exchange for duplicate wood specimens sent in response to special requests for such material for critical study, and in this way some 300 of the remaining 360 wood specimens in our collection will be sectioned for us.

In addition to the distributions referred to above properly authenticated material of certain genera has been supplied to Dr. Metcalfe at Kew and Professor Garratt at Yale.

21. Eight cases of decay in timber were investigated and slides sent to the Government Mycologist for identification.

22. Two show cases for 64 specimens have been added to the museum ; each specimen is represented by a low-power ($\times 5$ magnification) photograph of the cross section, with two wood samples, one showing the radial and one the tangential face.

23. At the end of the year work was commenced on the preparation of macroscopic descriptions of the commoner timbers. It is intended to publish these descriptions in *The Malayan Forester* and when the work is completed to bring them together in a single publication with a key which is hoped will be applicable to the greater part of the Indo-Malayan Archipelago.

V.—TIMBER TESTING.

(*a*).—Mechanical and Physical Tests.

24. Major tests were completed on green material of *temak*, *damar laut kuning*, *melantai* and *meranti rambai daun*, whilst *damar laut merah* was in hand at the end of the year. Reports on the first two were published in the March and September issues of *The Malayan Forester*.

25. Tests on fully air dried material of *keruing gombang*, *meranti tembaga*, *chengal* and *kapur* were completed and the results were published in *The Malayan Forester* for December, 1933.

The following is a summary of tests carried out during the year :—

(*a*)	Green material	3,149
(*b*)	Partially dry	882
(*c*)	Air dry	519
	Total ..	4,550
(*d*)	Moisture determinations	8,975
(*e*)	Shrinkage tests and specific gravities	331

26. Pilot tests were conducted on *keruing* (*Dipterocarpus crinita* Dyer) and *sol* in order to ascertain whether the strength values of these two species approximated to those of the two species already fully tested. Other minor investigations were carried out to determine the effect of *Diplodium* fungus on *jelutong* timber, and to compare the strength values of material from an unusually large *kumus* tree with the data obtained from normal sized trees tested in 1931, under the name of *Shorea costata* King.

27. Attempts to devise wood working tests with the aid of other departments were not particularly successful, and a promising arrangement to have such investigations made at Princes Risborough had to be deferred owing to the abolition of the Empire Marketing Board. Special sawing tests were carried out on material with a view to determining its suitability for export and in connection with the seasoning experiments referred to in paragraph 28.

(*b*).—Seasoning of Timber.

28. Experiments conducted by the Forest Engineer and the Assistant Engineer in charge of the Sentul laboratory continued with end and surface coatings. Reports on exported material so treated were most encouraging. One thousand two hundred and sixty sleepers were borrowed from the Railway Department and stacked under different conditions of exposure with the object of determining the minimum seasoning period prior to use in the line. There is some reason to believe that such seasoning may be unnecessary, though it will be advisable to continue it in the case of untried timbers. A certain amount of sawn timber intended for export was kept under observation at the laboratory and at Sungai Buloh.

VI.—WOOD PRESERVATION.

(*a*).—Impregnation.

29. Open tank treatment on seasoned *kempas* and *keruing* (*Dipterocarpus crinita* Dyer, was carried out on a fairly large scale. It was definitely established that adequate absorption of a 50/50 creosote-Diesel fuel oil mixture could be achieved in the

case of *kempas* by heating to 190° F., maintaining this temperature for an hour, and then cooling as rapidly as possible. The *keruing* proved to be a more recalcitrant subject, but there are indications that satisfactory penetration of the preservative will result from preliminary incising. It is unfortunate that this particular species (*D. crinita*) was chosen, as it appears to be the least amenable to treatment. The number of sleepers treated was 32 *kempas* and 515 *keruing*. Other materials impregnated by this means were some mixed pit-props for Malayan Collieries Ltd., some power line poles for the Electrical Department, some bridge timbers for the Public Works Department, and a number of test pieces for routine investigations. Pressure treatment was limited to small durability test specimens, which were dealt with in a single charge.

(*b*).—DURABILITY OF TREATED TIMBERS.

30. The pressure treated sleepers referred to in paragraph 64 of last year's report were inspected and found to be in good condition. It was, of course, hardly to be expected that renewals would be necessary at this early stage.

31. The "graveyards" were inspected in March and October. A report on the condition of the treated and untreated sleepers exposed to marine borers at Port Swettenham appeared in *The Malayan Forester* for November, 1933. A subsequent inspection indicated that attack, even on treated wood, was developing more rapidly than had been anticipated.

VII.—FOREST ECONOMY.

(*a*).—TIMBER.

32. The Research Branch was only indirectly concerned with the work in connection with trial shipments of timber to Europe and with the local activities of the Timber Purchase Section. These are dealt with in the report of the Director of Forestry, whilst reference to timber for special uses will be found in the sections of this report that deal with Wood Technology and Timber Testing.

(*b*).—MINOR PRODUCE.

33. *Jelutong*.—Tapping experiments continued at Bukit Cheraka and Sungai Buloh. The tentative conclusions reached in the previous years were upheld, and it can now be definitely stated that the Chinese method of upward and downward tapping is the most satisfactory provided that it is carefully performed with a short-handled tapping gouge. It is, however, regrettable to have to record that the departmentally tapped trees have been very severely attacked by *Batoceras* beetle, the ravages of which were hitherto attributed to careless tapping. Reports from the districts show that this pest was more than usually destructive in the latter months of the year. The results of tapping undersized trees (from 18 to 48 inches in girth) at Sungai Buloh were very disappointing, one ounce of latex per day being the average for 108 trees. The coagulated latex from both these experiments was sold to the Dreyfus Company and realised $300·40, which was almost sufficient to cover their cost.

34. *Other Minor Products*.—Investigations on other minor products are referred to in the chemical section of this report.

VIII.—CHEMICAL INVESTIGATIONS.

35. Chemical investigations were carried out by the Agricultural Chemist and his assistants, whose help is gratefully acknowledged.

36. *Damars.*—Separation of the components of freshly exuded soft *damar temak* produces the same materials as those obtained from the hard *damar.* It is concluded, therefore, that the hardening process consists of such a rapid polymerisation that it is impossible to separate unpolymerised material. A sample of *minyak kapur* from Kanching reserve was examined and found to consist of approximately 90 per cent. of volatile oil, the remainder being resins. The principal constituent of the oil (75 per cent.) was d-α-pinene, which is the main constituent of American turpentine; the sesquiterpene present (15 per cent.) was apparently identical with caryophyllene, which is an ingredient of oil of cloves.

37. *Essential Oils.* A sample of leaves of *medang serai* from Cameron Highlands was found to contain no essential oil. A sample of leaves of *chuchor atap* from the same source yielded approximately 1 per cent. of essential oil with a fairly pleasant odour. The oil consisted chiefly of a mixture of terpenes, dipentene, and possibly sabinene. There was no cineol present. The oil is considered useless for medicinal purposes.

38. *Cutch.*—Samples of local mangrove cutch from the Matang district were analysed, and recommendations made regarding an improvement in production.

39. Wood.—Some experiments were carried out regarding the utilisation of *terentang* for the manufacture of matches. Unfortunately the wood darkens on exposure to light and no simple means could be suggested by which either the darkening could be prevented or the darkened wood bleached.

40. Analyses were made of various species of Dipterocarpus (*keruing*) with a view to determining their identity by chemical methods, as their timbers are difficult to distinguish by ocular means. Unfortunately, the general similarity of the woods extends also to their chemical properties. The following woods were examined for relationship of extractives to durability: *tembusu* (*Fagraea gigantea* Ridl.), *penaga, kumus, dedali, kelat, nemesu* and *damar laut kuning.* From the nature of their alcoholic and aqueous extracts, *tembusu, penaga* and *kumus* would be expected to be of good durability and *dedali, kelat* and *nemesu* of only moderate durability. *Damar laut kuning*, while known to be durable, did not come up to expectations. Further analysis of the last wood is being made.

41. The durability of *merbau* wood appears to be explained by a slow rate of leaching, although the sawdust readily yields its extractives to water. The solid wood suffers leaching only at the cross sections, and is scarcely affected perpendicularly to the grain. Apart from its tannin-like water soluble extractive, the wood contains a wax, also a polyvalent phenol soluble in alcohol.

42. *Jelutong.*—Storage experiments carried out with Sarawak *jelutong* show that, provided soluble iron is excluded from the latex prior to coagulation and the crude coagulum is refined with boiling water to remove excess serum solids, the product shows no tendency to oxidise on storage. In this respect, therefore, *jelutong* latex from Sarawak resembles the local latex.

43. Experiments were carried out using phosphoric acid as a coagulant instead of acetic acid. One advantage of phosphoric acid is that iron phosphate is insoluble. Any soluble iron present in the latex would therefore tend to be precipitated, thereby minimising the chances of oxidation in the resultant product. As regards the amount of acid required to effect coagulation, experiments showed that by using 0·8 fluid ounces of 10 per cent. acid per gallon of latex and allowing the mixture to stand for three days a coagulation efficiency of 90 per cent. could be obtained. In the case of coagulation by boiling, the best results were obtained by using 0·16 fluid ounces of acid per gallon of latex, giving a coagulation efficiency of approximately 97 per cent. In the latter case an increase in the amount of phosphoric acid had an inhibiting effect on the coagulation efficiency.

IX.—ZOOLOGICAL.

44. As foreshadowed in the previous year's report, the activities of borers in timbers otherwise suitable for export were the subject of considerable concern. A questionnaire was circulated to all districts, but although a fair amount of information was forthcoming, it was mainly inconclusive. There seems to be some evidence that many of the dipterocarpus are attacked whilst standing, but that the larvæ do not penetrate beyond the bark except *via* dead wood, *e.g.*, an old wound or decayed branch. Others, such as *chengal*, are obviously subject to regular attack throughout their lives. The borers' activities are limited to the sapwood, but the abandoned borings are in due course included in the heartwood where they constitute defects that do not appear to impair the actual strength of the timber, though they render it quite useless for export to Europe, except to a certain extent in the so-called "wormy" grades. The ravages of borers are, of course, greatly intensified after felling, unconverted logs of the softer commercial species being riddled within the space of a few weeks or even days. The identity of the insects responsible for this form of damage is still obscure. A number of specimens was collected and forwarded to the Museums Department, where they received the attention of the Systematic Entomologist. Arrangements were also made to send material for investigation at Princes Risborough.

45. Reports on longicorn attack on tapped *jelutong* were received from the districts. As this pest was particularly active on the experimentally tapped trees in the Bukit Cheraka reserve, careless or excessive tapping can be ruled out as a predisposing factor. Remedial steps were undertaken, consisting of cutting away the damaged bark, and injecting and plugging the bore holes with ortho-dichlorbenzene and linseed oil, but practical prophylactic measures have yet to be devised. An unidentified longicorn was also responsible for the killing of a large percentage of sapling mahogany, the attack taking the form of girdlings and borings at ground level. The trees in the affected area were treated with tar, but it cannot yet be claimed that this has checked the attack as it may quite possibly be seasonal. The report of the shoot-borer attack on the same species, mentioned in para. 77 of last year's report, appears to have been incorrect, and was probably due to confusion with the pest just mentioned.

X.—METEOROLOGICAL.

46. The total rainfall for the year was 122·47 inches, five inches more than last year, which was hitherto a record. Distribution was, on the whole, fairly regular,

but there was an unseasonable dry spell during the latter half of October, which was responsible for many casualties amongst the transplants supplied to plantations. The wettest month was December with 18·84 inches; the driest January with 3·71 inches. The longest dry spell was one of 12 days from 30th July to 10th August. Maximum and minimum temperatures were 95° and 66° F. respectively, both in June.

XI.—EDUCATION.

(*a*).—Forest School.

47. The 1932-33 session was completed early in June. Of the sixteen students who had attended, thirteen were awarded certificates of proficiency and four of these passed with credit. The Cubitt Prize was gained by Inche' Jaffar bin Mohamed Salleh, Forest Ranger II, Perak North. This prize, as previously, took the form of a prismatic compass and case.

48. An addition to the curriculum was the use of blasting powder in the demolition of rocky outcrops such as are met with in road construction. As part of the practical work a forest reconnaissance was undertaken in mountainous jungle in the State of Perak; it served the excellent purpose, among others, of acquainting the students with commercial tree forms not normally encountered in the lowland forests where the majority have spent most of their service. Another useful practical exercise was the constitution of three volume sample plots in *meranti* forest. A further innovation was drill instruction given by non-commissioned officers of the Federated Malay States Police, for which thanks are due to the Chief Police Officer, Selangor. It has resulted in a very distinct improvement in the smartness of the students.

49. The seventh session of the school commenced in July, with a complement of 22 pupils, of whom 19 are from the Federated Malay States and one each from the Straits Settlements, Johore and Kedah. So far this is the largest number of students who have attended any one course. A number of the original nominees were found to be unsuitable at the beginning of the course and were replaced by more suitable men.

(*b*).—Other Instruction.

50. The Wood Technologist and a newly recruited Assistant Conservator of Forests attended the school courses in tree and timber identification. Also, in conjunction with the school, they received practical training in the methods of forest reconnaissance, and accompanied the school on tour in Perak, Selangor and Negri Sembilan.

XII.—PUBLICATIONS.

51. No new *Records* were published during the year. The departmental journal, *The Malayan Forester*, appeared at quarterly intervals and formed a useful medium for the publication of reports of general interest, some of which were reprinted for free distribution, whilst others will be combined into departmental "Records" in due course. Although *The Malayan Forester* has undoubtedly satisfied a want, it does not, and probably never will, aspire to the dignity of a purely scientific journal. For this reason it is not suitable for the publication of articles of a highly specialised character.

52. Through the courtesy of the Director of the Singapore Botanic Gardens, Mr. C. F. Symington was able to publish an important paper entitled " Notes on Malayan Dipterocarpaceae " in vol. VII, part 2, of *The Gardens Bulletin*. This paper, which will be succeeded by others, is a notable contribution towards the solution of the many difficulties that exist in this group.

53. The appearance of Mr. D. B. Arnot's *Ilmu Sukat-sukatan Tanah** was delayed through various extra-departmental causes, so that it was not ready for the use of the 1933-34 class. Printing was, however, completed soon after the end of the year. A further vernacular text book by the same author dealing with timbers and their identification was prepared for publication early in 1934.

54. The issue of the monthly gestetnered *Research Bulletin* ceased at the end of the year, except for the abstracts of current literature, which will continue to appear as before. A programme of research for 1934 was circulated both locally and abroad.

* Methods of Land Surveying.

KEPONG,
2nd March, 1934.

J. G. WATSON,
Conservator, Research.

INDIAN FORESTER

DECEMBER, 1934.

SCIENCE AND PRACTICE.

It is remarkable in how many instances the correctness of the ancient practices of agriculture has been confirmed by scientific research and the same seems to be true of forestry. For many years experienced officers contended that the reason for failure of natural regeneration notably in the case of spruce and silver fir but also in deodar and blue pine was due to an excessive layer of undecomposed humus which absorbed water like a sponge and dried to dust in the hot weather in May-June.

At last, it has been possible to investigate this matter scientifically and a careful study of Dr. Mackenzie Taylor's article in the *Indian Forester* for June 1934, will show that the above theory has received ample confirmation by Dr. Taylor's investigations. Five samples of soils were investigated ; on two regeneration was being obtained, on three nothing was coming up. Dr. Taylor shows that the three soils which were not giving regeneration had an A horizon containing over 11 per cent. organic matter from 23 to 46 cms. in depth, whereas those soils on which regeneration was coming up had only a similar depth of 6 cms. His conclusion that, if the seedlings have not made sufficient growth before the soil dries out, they will perish, is the same as propounded in the Kulu working plan 15 years ago. He also shows that this A horizon absorbs large quantities of water to the detriment of the water content of the lower layers of the soil. The importance of a knowledge of forest soils is now generally recognised but apart from Barrington's work in Burma and Hole's work on sal, very little has been done owing to a lack of knowledge of the subject or of facilities for carrying out such investigations.

It is hoped to be able to supply such facilities at the Forest Research Institute in the near future.

Many of our regeneration problems must be connected with soil, and once the scientific reason for failure or success has been established, the forester can then consider how best to put this knowledge to practical use.

It is hoped that Research Officers in all provinces will give this subject the attention it deserves.

LIFE IN A HIMALAYAN VALLEY.

By E. C. Mobbs, I. F. S.

III.—Recreations and Marriage Customs.

It has been mentioned that the people of the Tons Valley have a fair amount of spare time. The men have more than the women, for from one ploughing time to another the men have little to do, while the women always have the winnowing and grinding of the grain and other domestic matters to attend to, when they are not engaged in field work. Yet there seem to be few definite recreations, and a large amount of the spare time is just lazed away.

Games of any sort are practically unknown and only once have I come across anything in the nature of an organised game. This was among the villages at Naintwar, the most populous part of the Tons Valley. I happened to be there on the one special day in the year that the game is played. The *sadar syana*, *i.e.*, the head man of the local group of villages, invited me to come up with my wife to see the fun, and the combined village bands turned out to escort us with much noise to the field of action. There we found quite a large assembly of men from all the surrounding villages gathered on a fairly level field, while on the next terraced field above sat or stood all the children and women folk, arrayed in their holiday clothes and jewelry. As soon as we had taken our seats on the centre of the bank, the fun began. All the men crowded round and one of their number threw among them a large ball, like a Rugby

LIFE IN A HIMALAYAN VALLEY.

19. A double swing at Arakot.
Swinging is one of the few recreations of the people, and is indulged in by the grown up men as well as by the children and young women.

20. Drums and trumpets are the chief musical instruments of the Tons Valley.
The drummers are skilful, but the trumpeters rarely manage more than spasmodic shrill blasts.

Photos by E. C. Mobbs.

ball, made of stuffed goat's skin. Men pounced upon it and upon each other from all directions and a great scrum ensued, one half of the men trying to get the ball to one side of the field and the rest to the other side. There were so many men, for each side comprised all the men of several villages, from the youths to the grey haired, that the ball once thrown never appeared again, and one watched its progress by the swaying mass of men. The ball having reached one side of the field, the game stopped and started again from the centre, quite a number of games being played till it began to get dark.

The whole game appeared rough and disorderly. Many of the men had pulled their trousers above their knees and had discarded their shoes to facilitate leg work in the scrum. And many had also discarded their caps, a rare thing for them to do in front of me: a man is usually most disconcerted if he is seen hatless. Yet apparently there was some regulation, and great importance was attached to the ball being thrown each time from the exact centre of the field. On one occasion it was not thrown from the centre and the thrower was very severely handled as a result.

Apart from this, I have not come across any game in the whole district, either among the grown-ups or the children. The children do not play among themselves, nor do their parents play with them. On one occasion only, I surprised a young man running with a little boy on his shoulders, both laughing gaily, but only once, and even then they stopped immediately they saw me and became serious, as if ashamed of being seen running and laughing.

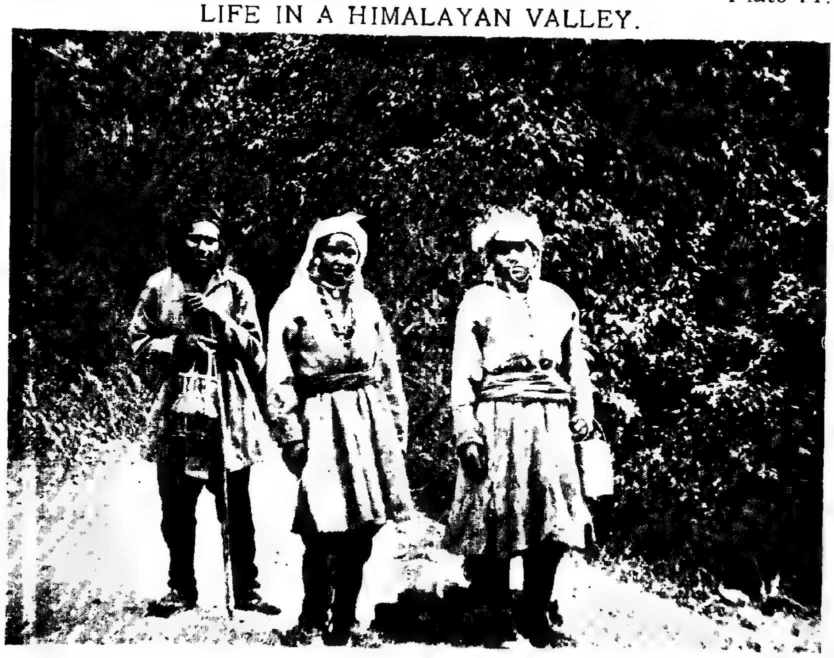
As distinct from games, a mild recreation is to be found in some villages in the form of a swing. This is usually a rope tied by its two ends to the branch of a tree, a blanket placed in the loop forming the seat. Such swings are often used by the grown-up men, but are mostly patronised by little boys and the young women. In Arakot village there is a double swing erected in the courtyard of the village temple, and it seems to be almost exclusively used by the village belles. There are two rough wooden seats on the ropes, which hang from the same structure, and two girls sit facing each other.

Among the recreations, I suppose, must be included the feasts, further mention of which is made later in connection with the marriage customs and the religion. In addition to the actual feasting, music, dancing and singing play an important part in all festivals. As there are many minor festivals, these consequently form a frequent occupation in the agriculturally slack seasons. Music is of course essential for dancing, so each village has its musicians, who are usually attached in some way or other to the village temple. The occupation runs in families, but only very rarely is a man a whole-time musician ; he is usually engaged in ordinary agricultural work and music is a side line.

Musical instruments vary considerably, but they fall into two main classes -drums and trumpets. The drum may be any shape or size, from small ones a few inches across for the tiny boys just able to toddle about, the youngest of the family, to large ones for the men. The trumpets may likewise be large or small, and they may be of brass or silver or a mixture of both, chased or hammer worked with crude patterns. The drummers are skilful and maintain the rhythm necessary for dancing, but the trumpeters rarely manage more than spasmodic shrill blasts.

Dancing is indulged in by both the men and the women, the former perhaps more than the latter. Men of all ages dance, but usually only the younger women, and rarely the older women, who become old and feeble beyond their years to a much greater extent than do the men. In the usual form of dancing a large ring is formed, each person with his arms around the backs of his two neighbours. The "band" sits in the centre of the ring and the dancers go slowly round and round. At first sight it appears as if they do nothing but an extremely slow shuffle round and one wonders how the people can keep it on for the hours that they do. But closer investigation shows that there are definite steps, even though each step may only mean the movement of a foot by an inch or two. In one dance I counted a cycle of 16 different steps, and in spite of this number all the people kept time and rarely had to look at their feet.

LIFE IN A HIMALAYAN VALLEY.



21. Homespun clothes of wool and goats' hair are typical of the upper parts of the Tons Valley.

These people are passing through the forest on a visit to a neighbouring village. A fair amount of visiting is done in winter, the agriculturally slack season.

22. Goat skins are used for carrying grain or flour.

The basket is made of local bamboo (*Arundinaria falcata* and *spathiflora*), and usually contains wool and goats' hair, which is spun as the man walks along.

The shoes are made of local grass. *Photos by E. C. Mobbs.*

In certain festivals sheep and goats are killed for the feast. In some villages the general excitement is first raised by the almost hypnotic effect of an axe dance. The leader carries a large beheading axe, which he swings slowly above his head and round himself as he dances. Each time I saw this dance, it was performed only by the older men, and possibly it is performed only by the heads of families, one sheep or goat as a rule being killed per family. Other dances seem to be for men only, but in most the women also join, either mixed indiscriminately with the men, or in two parts, the women forming one half of the circle and the men the other half.

Very frequently the people sing or chant as they dance—songs with little variation of tune, but sung to the rhythm of the music. To a stranger the voices sound harsh and discordant, but heard from the other side of a valley, the singing sounds rather pleasant and in keeping with the general surroundings. The songs may be more or less established in nature, dealing with legends of their gods and similar matters, or they may be purely temporary, dealing with recent local events. Most of the songs have something to do with sex at the bottom of them, although occasionally a local event of another nature may be the source of inspiration. One such case was when a certain forest block, which had been closed to burning for regeneration purposes, and in which a village was situated, was opened to burning for the benefit of grazing on the petition of the villagers. In the particular circumstances they had been very hard hit, and when their petition was granted, a song was at once composed to commemorate the occasion.

Individual dancing and singing is rare and is confined to professionals. One such was Natti of Hanol village, who was quite a good dancer and singer, her father usually accomanying her on a small Indian harmonium. With her sister, the three of them could earn a fair amount at special festival times by singing in villages and at the camps of sawyers and other people working in the forests. Other professional dancers come over from the Jumna valley for special festivals, but their visits are only to the camps of the forest labour.

The local people do not care much for these dancing girls ; they prefer to dance and sing themselves in their own fashion.

The marriage customs are rather diverse, for in this comparatively small area polyandry, monogamy and ploygamy exist side by side. Polyandry is more particularly confined to Jaunsar-Bawar and the lower parts of the Tons Valley, where it is openly admitted. One village headman I met had six fathers and was only one-fifth of a father himself! I suspect that polyandry is also of fairly frequent occurrence in some villages at any rate of Tehri-Garhwal, although it is not openly admitted. Whenever I endeavoured to find out, I was informed that it did not occur here, but that it was common in certain other villages. But those other villages in their turn would deny the practice and refer me back to the first villages. In only one case did the head man of a Tehri-Garhwal village tell me that polyandry existed in his village, while on the other hand, he himself boasted of having two wives.

The husbands of the same woman are always brothers with the same set of fathers, although if their fathers had shared more than one wife between them, the brothers need not all be the sons of the same mother. These brothers may share one wife between them, or they may have two or three wives in common, according to their economic condition. For in these parts a girl is not the financial burden to her parents that she is in other parts of India. When she is married she is more or less sold, the money paid by her future husband or husbands being paid to her father or her nearest male relative. So several brothers may at first be able to afford only one wife between them, and later on may increase the number of wives as their financial condition permits. The eldest brother has prior claim to the wife, and any children resulting are considered to be his rather than the children of his younger brothers. In his absence, the next brother has prior claim to the wife, and so on. Any brother, if he can afford it, may take a separate wife, in which case he may entirely separate from his brothers, taking his share of the patrimony, with due deductions for any sons that may have been born of the common

wife, or he may still share the common wife in addition to having his own, which obviates the necessity of sub-dividing the common property. The system permits of all sorts of arrangements. One case is mentioned in the district gazetteer of a family of eight brothers, six being the sons of one mother and two of another. The eight first married three wives, who were possessed in common; but subsequently one of them took another wife. Finally the six real brothers took the first three wives and the other two brothers shared the new wife.

The birth rate and the census figures show an excess of males over females, and this is probably the chief cause of polyandry. But at the same time the deficit of females may possibly be partly the result of the system. Female infanticide, which generally results from polyandry, has not been found to exist in these parts. But baby girls are probably not so well cared for as baby boys, resulting in a higher mortality of girls, while the regulations regarding registration of births are not so completely adhered to as to make the birth rate figures entirely reliable.

Locally it is said that the advantage of the system is that it prevents the sub-division of land and consequent quarrels; for when all the brothers take a common wife, they inherit their fathers' property as common property. The system must also have some effect in keeping the population down, which is perhaps not altogether bad. Already almost all the cultivable land is under the plough, and although the density of population is very low, the land cannot support any more people. If there is a real basic deficiency in the birth rate of girls, then polyandry is the only system that would prevent the introduction of women from other parts, which would cause an unwanted increase in the population. Alternatives, of course, would be for some of the men to move off elsewhere, which they would not do, as it would mean giving up their share of the village lands, or for the population to increase and to engage themselves in forest and other works, in the same way as do the men of British Garhwal. This again the men are loathe to do, being essentially

lazy, but it is what they will have to do if the population increases much above what it is at present.

The effect of polyandry on the women is that they become prematurely old. The young girls are often pretty, or at least good looking. But they change so rapidly, looking quite old when they are still really comparatively young, that there are practically no women at all who look what we should call middle-aged. They are just young or old, and the transition period from the one appearance to the other is very short. I have often wondered whether in these conditions the women do not have so many children as they would in more favourable circumstances, and whether this is another direct factor in keeping the population down.

It is hard to say whether polyandry increases immorality or tends to decrease it. The general standard of morality is always said to be very low, but perhaps without polyandry, which permits a certain amount of legalised promiscuity, conditions might be worse than they are.

Monogamy is the general rule in the Tehri-Garhwal part of the Tons Valley, while polygamy is comparatively rare, and is restricted to a few only of those who can afford to have more than one wife. Most of the people consider polygamy as inadvisable, owing to the innumerable domestic quarrels that result. As one man said to me, a man who takes more than one wife finds that life is not worth living!

A girl is usually married at eight or nine years to a boy two or three years her senior. Occasionally the ages may be equal and they may be a little higher, while not infrequently they are less. Betrothal often takes place at a very tender age, and it has been known for a baby not one year old to be unofficially betrothed by mutual arrangement between the parents.

Marriage is a simple affair. The boy's father, brothers and male relatives proceed to the village of the girl to be married and there have a small feast and pay over the price of the girl. A day or so later, the girl, dressed in her best clothes and jewelry, is escorted

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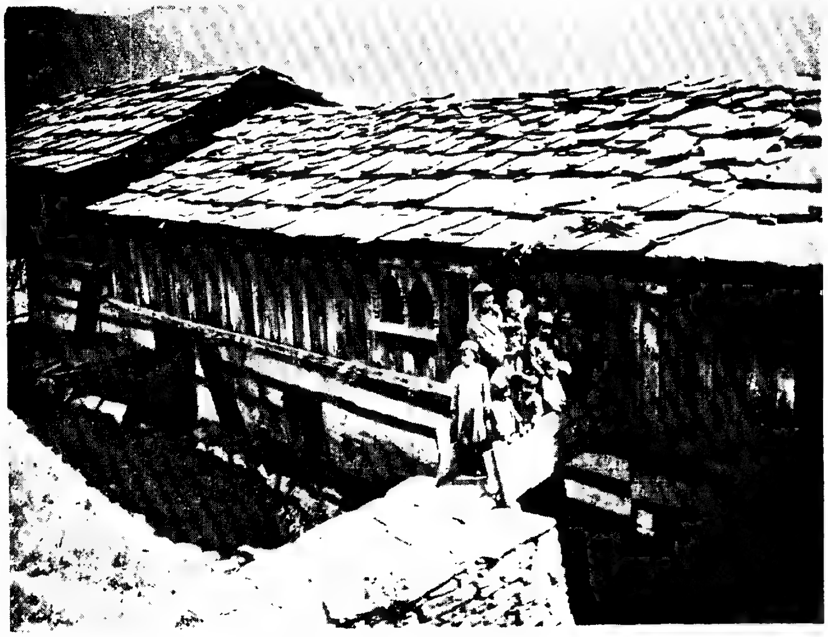


23. A long type of house for a large family.
Slate slabs have been used in this case for roofing, and the verandah round the upper part of the house, where the people live, has been enclosed.

24. A family group.
The children are well cared for and are often very good looking, but the girls in particular age very rapidly.

Photos by E. C. Mobbs.

to the home of the bridegroom by the visiting party and all her own relations. The whole procession is accompanied with much beating of drums and blowing of trumpets by as many " musicians " as the party can afford to muster. On reaching the home of the bridegroom, who has waited there, further feasting and dancing take place and the marriage is consummated. with or without the help of a priest. There are many minor customs which may be observed, according to the locality. For instance, one procession I watched halted when it came to the outskirts of the village where the bridegroom lived. A large sheet was thrown over the bride, who was picked up by one of the men of the party and was carried through the village. On reaching her future abode, she was put down and the sheet was removed. The idea apparently was that her first step in the village should be on the threshold of her new home, and that the first person and the first part of the village that she should set her eyes on should be her future husband and his home, which would be her new home.

The price paid for a wife varies considerably. One of my orderlies, a Jaunsari, informed me that he paid Rs. 30 for his wife, but I have come across cases where as much as Rs. 200 have been paid. The initial price of a girl is of great importance in the Tehri-Garhwal villages. For here divorce and remarriage are quite common. If a woman once married wishes to change her husband, she can divorce him and can be married to another man on the condition that the second man pays to the first husband twice the original amount paid for the girl. Suppose now that the woman changes husbands again, the third man must pay to the second twice again, *i.e.*, four times the original price. It has been known for a woman who is very beautiful in local estimation to change husbands in this way several times. And as the purchase price increases in geometric progression, she becomes a veritable pearl of great price !

It is this remarriage system, carried to excess. which is inducing fathers to demand very high payment for their daughters. For a father who has taken some care in selecting a suitable husband for his

daughter does not want her to be remarried. The best way to prevent this is to fix the initial price high, so that double the amount will be a serious consideration for any future paramours.

(*To be continued*).

ASSAM FORESTS AND THE RECENT FLOODS.

By M. C. Jacob. I. F. S., Assistant Conservator of Forests, Kamrup.

The province of Assam is not unused to floods but the one which some of its districts experienced recently was perhaps in some ways the severest. The greatest damage to life and property occurred in the district of Nowgong, but it was in Kamrup that the forests were most affected.

2. Most of the forests of Kamrup under systematic working lie in the plains at the foot of the Khasi Hills. The timber-growing areas are generally confined to spurs that alternate with narrow strips of low land and cultivation. Village sites are situated on high ground close to the forests. The main timber crop is sal of moderate to poor quality. A few of the compartments, however, extend into low hills reaching up to 800 feet in height.

3. This part of Kamrup forms the catchment basin for much of the water that comes down from the Kasi Hills along rapid hill-streams. Incessant rains during the second half of June caused these streams to swell up and inundate the plains below. Usually it is only the low lands and paddy fields that are affected by such floods: this year, however, the water rose in a few hours time to the village sites, flooded out many villgers from their homesteads, carried away their cattle and compelled them to seek shelter in the higher lying parts of the forest reserves. Paddy lands ready for the season's sowing got badly silted up with sand deposited by the overflowing rivers, and have become useless, at least temporarily; and so, many of the villagers had to be settled on fresh land. Villagers near Kulsi (the

most important forest centre in Kamrup) had to be helped with rice and paddy by the Divisional Forest Officer.

4. Water rose in the compound of the Forest Office at Kulsi and within an hour it was more than waist high in the office itself. Records, venerable though musty with age, floated up and were carried away by the floods, some to be rescued by the indefatigable Range Officer after a strenuous chase for about two miles down the river, others to be lost for ever. '*Kacha*' Guards' barracks which had been an eyesore all along got their walls washed and their posts knocked aslant.

5. While cattle were being washed away, homesteads destroyed and safety to human life threatened, a tiger carried down by the floods, after supreme effort found its refuge in one of the outhouses of the Inspection Bungalow at Kulsi, the only dry place in the locality. And it took all the energy left in the already tired Ranger and his staff to drive out the tiger from there. But the episode did not end at that. Four Guards had been placed on duty for the night at the Forest Office. But, they rushed out of the building in terror on finding the tiger return and determinedly enter the office to settle down for the night. Frantic efforts were made to force the tiger out of the office but it preferred to face the consequences of staying in there to sallying forth into the wet night again, even after a few blank cartridges had been fired. The tiger succeeded in spending the night in the office, much to the chagrin of the staff whose vigil had thereby been rendered all the more taxing.

6. In the meantime, a tragic scene was being enacted not far away. An enthusiastic Forester was fighting his way through the flood to his beat office. in spite of the advice of the people of the locality. His body was found floating in a bed of reeds two days later. Forester Raghunath Mahanta died a martyr to a sense of duty.

7. A good seed year had raised early in the season great hopes of a plentiful crop of sal seedlings, in spite of storms in May having blown down much of the seed prematurely; but, the floods completed

the work of destruction that the storms had started. In the sal forests in the plains in general, all the fresh seedlings and germinating seed were washed away. A slimy deposit of silt was found left on all undergrowth, bent down to the ground by the force of the flood water. It was noticed that areas where seed had been dibbled in, bore a fair crop of seedlings even after the floods, whereas in areas where broadcast sowing had been adopted only very few seedlings were to be found. It was, however, gratifying to note that the older seedlings were none the worse for having been submerged for varying periods (from a few hours to as much as three days). On the hills, unaffected by the floods, an abundant crop of tender sal seedlings was found making its way through thatch—pointing to what could have been achieved in the plains too, but for the floods.

8. The floods, however, were not an unmixed evil. *Eupatorium odoratum*, the major curse to regeneration in Kamrup was in places completely killed out by submersion. Prior to the floods, efforts were being made, not with much success, to keep the river Kulsi (the main floating stream through the area till recently) to its main channel, and prevent the tendency for its waters to flow down a side-stream, the Noa nadi. It would now appear that the floods have so effectively silted up the Noa nadi at its mouth that the Kulsi will again be the main stream for floating.

9. There is no gainsaying the fact that the flood has considerably set back the progress of regeneration in the plains forests of Kamrup. That it is one of the factors to be taken into consideration in any scheme of regeneration of these forests has become apparent.

THE MONAS GAME SANCTUARY, ASSAM.

BY C. A. R. BHADRAN, I. F. S.

Introductory.—It is perhaps not known that the province of Assam took a lead in the matter of preservation of its wild fauna some years ago and that there are a fair number of forest reserves gazetted as Game Sanctuaries. Though, due to financial difficulties,

it has never been possible to arrange for the enforcement of strict protection which is implied in the word "Sanctuary." In fact, only the most important of these, the Monas Sanctuary, has had some attention paid to it—by the poachers to a great extent and of necessity by Government also. It is proposed to set out here the conditions prevailing at present and the proposals contemplated for the better protection of game in this Sanctuary, and perhaps later, elsewhere in the province.

Location, Physical Features, Types of Forests.—The Monas Sanctuary is situated in the Brahmaputra valley to the north of the river, mainly in North Kamrup District, extending also a little into Goalpara District. It is about 150 square miles in area, forming a strip about 10 miles wide along the foot of the Bhutan hills. The drainage is from north to south, of which the Monas and its branch the Beki are the most prominent features, while innumerable small streams also traverse the area, all ultimately finding their way to the river Brahmaputra.

The Sanctuary itself is flat and rather low-lying with an abundance of extensive marshes overgrown with reeds. It is, however, mostly covered with a dense growth of coarse grass and tall reeds, with an occasional tree (mainly *simul*) standing up, here and there, above the grass. But along the Bhutan boundary occurs a strip of open tree forest, in which can be recognised such species as *Bridelia* sp., *Acacia catechu*, *Dalbergia sissoo*, *Cedrela toona*, *Amoora* sp., *Sterculia villosa*, *Careya arborea*, *Dillenia indica* and others. The undergrowth consists of light grass and species of *Flamingia* with species of *Eupatorium* invading gradually. The grassy areas get burnt annually between the months of December and March, but the grass grows again into an impenetrable mass, but for elephant paths and tunnels of game animals.

Object of the Sanctuary.—The prime object of the Sanctuary is to afford all possible protection (and encouragement to multiply in peace) to the rhinoceros. But the task is rendered extremely difficult on account of several factors. The rhino haunts are rarely of easy

accessibility and a very conscientious game-watcher may not be able to visit them at all or even make sure of the absence of poachers from the vicinity. But the price on its head (or we may say, its horn) is so great that it is worth while for the poacher to take all the risk, trouble and inconvenience involved in the attempt. A rhino horn once successfully smuggled into a place like Calcutta finds a ready sale (especially among the Chinese, who have a great faith in its *aphrodisiac* properties) and will fetch anything up to Rs. 15 per *tola*. Besides the horn, every other part of the body of the animal is valuable, the meat being highly valued by the local Hindus not for its edible qualities but for its supposed sanctifying properties ! A factor helpful to the poacher is the habit of the animal of laying its droppings successively in the same place : so that, one has only to wait at a fresh heap of dung to get at the animal when it turns up next.

After the rhino, the buffalo, the bison, and the swamp deer demand our protection. Efforts have also been made to keep out ivory poachers ; and the present low price of ivory proves a further check to their activities.

Life in the Sanctuary.—Life in the Sanctuary is varied. In the low-lying marshy lands and in the grass areas are found rhino, buffalo, pig and deer as also bears ; while elephant, bison and sambhur seem to prefer the tree-jungle at the foot of the hills.

The Rhino.—The rhinoceros is said to have been plentiful some years ago, but poaching on a large scale has so reduced their numbers that it is very rarely that one may even be sighted nowadays. The few that still exist have learnt to keep far out of man's way. It is estimated that during most of the year about 30—40 rhinos make their home in the Sanctuary. It seems however that those to the west of the Monas migrate northwards into the outer hills of Bhutan during the dry months of the year. Luckily all shooting is prohibited in Bhutan ; and though no staff exists to enforce the rules, the punishment meted out to the offender, if detected, is likely to be so heavy as to prove a deterrent in itself. It is a pity, however, that

the prohibition is not very effective against the Nepali settlers in Bhutan.

From the foot-prints observed, it is surmised that there are two distinct species of rhino in this Sanctuary: in one case, the footfall indicates a heavy-bodied animal, the footprint is more or less rounded and the three nails are set out almost equally from the edge. In the other case, the animal seems to be of lighter build, the footprint is distinctly oval, and the median nail is set well projected in front compared to the side nails. Mr. Milroy thinks that the latter may be *Rhinoceros sondaicus*; but in the absence of knowledge of any hornless rhinos in the area, the presence of this species cannot be vouched for.

The Elephant.—During the winter elephant herds are not at all common in the Sanctuary, but with the first flush of green grass(after the burning) and the first shower of rains in April they make their presence apparent in the tree-jungle and in the high grass-lands by the innumerable tracks they make all over the place. It must however be added that solitary bulls (*goondas*) live permanently in the Sanctuary, each having almost a defined " beat " for itself. The herds vary in strength from ten to twenty generally. But herds over a hundred strong have been known, though they are very scarce nowadays. It might be noted as an interesting fact that the only animal the elephant does not relish meeting is the rhino; rather. The distrust would appear to be almost mutual.

The Buffalo.—The buffalo inhabits mainly the river beds of the Monas and the Beki and the grassy-lands on either side of them. It is felt that protection has definitely aided this species and that it is on the increase in the Sanctuary. A small or big herd is almost certain to be sighted in either river-bed on a warm day. The local Boro tribes are said to be very keen on its flesh (in fact they are very fond of any flesh) but the risk nowadays is too great for them to go after it.

Bison.—The bison resides in the tree-forest in the north of the Sanctuary near the Bhutan boundary and is only occasionally found

in the flat lands below. It is commonly seen during the rainy season from April to October but renders itself rather scarce at other times of the year.

Deer.—Sambhur occurs in pairs or small groups in the strips of tree jungle, and can be found even far away from any source of water. Big-sized specimens are quite common, but the antlers are rarely remarkable for their spread. The sambhur is perhaps the easiest to shoot from an elephant, as it stands and gazes at the elephant while the shikari can take his aim to drop it.

The barking deer is also a dweller of the tree-jungle and lives mostly singly.

The females of swamp and deer generally occur 8—10 together, while the males live apart. They inhabit highlands, close to water in the grassy areas. Sometimes they move in large herds of as many as 200—300 heads.

The hog-deer occurs invariably singly in the grass and is very quick on its feet. Occasionally its coat is found to be lightly spotted. The true spotted deer (chital), however, does not occur in the Sanctuary.

Other Animals.—Pigs are common all over the place, and some of them are of record sizes. Neither the Himalayan nor the Sloth Bear is numerous but they have the unfortunate knack of making a sudden appearance at close quarters when least anticipated. The pigmy-hog is also known to occur, though it is rather rare. Monitor lizards ('*guisaps*') are common and can be frequently sighted after a shower of rain.

Of carnivora, tiger is most prominent (being found distributed all over the area), though leopards are also known. The latter, however, appear to haunt the neighbourhood of villages in preference to living entirely in the forests ; but the real forest leopard when met with is comparatively of larger dimensions.

Wild dogs are extremely rare though they are met with in the area.

Aquatic Life.—The Monas has a reputation for good fishing—mainly for its big-sized mahseer. Others are plentiful in almost all the streams in the Sanctuary, and are responsible for the destruction of fish in these streams. Crocodiles of the long-snouted variety live in the deep pools in both the Monas and the Beki.

Birds.—Peacock and jungle-fowl are commonly noticed from January to May. Partridges, quails and floricans are met with also, but are not so common. On the Monas and Beki rivers, "*Brahmini*" ducks (in pairs always) and *Mergansers* can be seen now and again.

Need for Protection : Activities of Poachers.—The need for protection of the rhino was felt as early as 1905, when the Monas Sanctuary was gazetted as such. Subsequently, a game-keeper with a small staff of game-watchers to assist him was appointed. The main duty of these men has been to patrol the Sanctuary area and arrest any poachers and trespassers they may come across. The local Boro tribes (Boros, Kacharies and Meches) are all jungley people accustomed to hunt animals in the jungle for their food. It was quite a task to make them realise that hunting became illegal with the formation of forest reserves in the locality. Even now it cannot be said that they are completely reconciled to the new order of things. They certainly do not see any need for protection, especially to the detriment of their food-supplies.

But, it was only at a later stage that the value obtainable for the rhino horn attracted the attention of monied shopkeepers and businessmen in the neighbourhood, who began secretly financing and encouraging the local tribes (with supplies of ammunition and promises of large rewards) to go after the rhino in the jungle, while they themselves remained safely in the background. The proposition became so paying that poaching began to be organised on almost a commercial scale and the villagers became daring poachers. Some ingenious dealers even started manufacturing false horns ! ! Unlicenced guns were plentiful in the villages and poaching became far too extensive for the small staff to check effectively.

Steps taken against poaching.—At an early hour, a detachment of the Assam rifles was despatched to tour the area adjoining the

Sanctuary for some weeks. All suspicious places were thoroughly searched; and a good many unauthorised guns were seized and confiscated. Professional poachers who had migrated into the neighbourhood from adjacent districts elected wisely to leave the place in good time. The situation rapidly improved, but it was only after most of the rhino had disappeared.

Subsequently, gazetted forest officers have been posted off and on, on special duty, to tour the Sanctuary for some months at a time, and to keep the poacher scared by their constant movements. It must be said that all this has had a very salutary effect and that large-scale poaching is practically non-existent now. There was no reason to suspect that any attempt was made to shoot a rhino in the Sanctuary during the past year. Of course, petty cases of trespassing and poaching do come up now and again; but none of the culprits concerned could had access to the rhino.

The present Sanctuary staff consists of an officer-in-charge, a game-keeper, two head game-watchers and 15 game-watchers. The men are located in pairs at different control points in the Sanctuary and are expected to regularly patrol the areas adjoining their camps. The staff is certainly inadequate to assure complete protection but meets the purpose for the time being. The main difficulty is that even if a couple of watchers do locate a poaching camp (which is bound to be large, if the poachers are after rhino), they are not able to arrest the poachers. Dependence is placed mainly on the poachers not giving fight but taking to their heels at the sight of the Custodians of the Law: and, it does happen sometimes that the watchers manage to arrest one of the slower among the poachers, though it does not always follow that the trying magistrate finds the evidence sufficient to punish the poacher, in spite of his having been caught red-handed!

Difficulties in the way of Protection.—The upkeep of the Sanctuary is now a charge on the forest revenues of the province. These arrangements being on a temporary basis, the chances of their being kept up even at the present level cannot be considered bright,

especially in view of the present poor financial condition of the province. Apprehension is also felt that, until the people of the province themselves begin to take a real interest in the fauna of the locality, their representatives in the future Government may not be inclined to maintain the Sanctuary. Of course, if steps towards preservation were to wait till the people learn to value animal life at its true worth, there may be no rhinos left by then for preservation. Therefore, the success of the Sanctuary will entirely depend on its being able to pay its own way, unless the proposal to make sanctuaries a charge on central revenues materialises.

Formation of National Park not possible.—The first method (of making the Sanctuary pay) that suggests itself is to convert it into a National Game Park, wherein visitors will be admitted, on payment, for observing the animals in their natural surroundings. But this suggestion is ruled out owing to the absence of roads and buildings in the sanctuary as they will necessitate a large initial capital outlay to provide for these fundamental amenities to attract the visitors. The money is not likely to be forthcoming. Further, the local people will take no interest in the matter; at any rate, they will not be inclined to pay for going into the jungle! Even if people can be found to avail themselves of the opportunity afforded, the season during which such arrangements can work is all too short—only about three months in the year, from January to March. During the rest of the year the tall grass and reeds and the heavy rains preclude all possibility of anything like comfortable touring in the Sanctuary, leave alone sighting animals in the dense jungle. Lastly, it is felt that considering the area of the Sanctuary, the game animals (of the larger species) are not plentiful enough for them to cross the paths of visitors occasionally. All these disadvantages definitely render the formation of a National Game Park in the Monas Sanctuary impracticable.

Proposals for the future.—The only other alternative—a proposal which owes its conception to the Conservator of Forests, Assam—is to raise at least a part of the funds required by permitting restricted shooting to individuals and parties at prohibitive rates.

Besides, the shooting will be confined to the outer parts of the Sanctuary to the east and west, leaving the central portion an inviolate Sanctuary. This may seem to go against the principles governing sanctuaries, but it must be agreed that it is better to permit a known number of animals to be shot under control rather than have an unknown number poached without any advantage to the Sanctuary. It is anticipated that the glamour of shooting in a Sanctuary will attract really wealthy shikaries who will not grudge to pay handsomely for the privilege and who will not expect to balance their expenses with the material return of the " bag " collected.

Under this scheme, the number of shikar parties to be permitted every year will be controlled by the Conservator of Forests, who will administer the Sanctuary directly. He will see to it that only true sportsmen-naturalists who can be relied upon to observe all laws in force, are admitted into the Sanctuary. The number of animals they will be allowed to shoot (including those wounded) will be defined, dependant on the estimated strength of the species. There will also be restrictions as to the size, age of the animals that are shot, besides close seasons. Further, it will be provided that selling of the trophies or of the flesh for trade shall not be done.

A fee (heavy in comparison with ordinary reserve forest rates) will be levied for the permit allowing the party to enter the Sanctuary for camping and shooting. And on top of this, royalty will be realised on each animal shot or wounded, according to a schedule of rates, graded according to the rarity and value of the animal, the rhino, of course, being priced most.

The parties will be provided, as far as possible, with facilities such as elephants by the Forest Department on payment of a hire at scheduled rates. The parties will be accompanied by game-watchers who will help them in looking for game and also take note of their activities in the Sanctuary on behalf of the department.

It is believed that the presence of sportsman will in itself prove deterrent to the activities of the poacher. Further, it will help the authorities to know from time to time, the exact state of animal life

in the Sanctuary, indicated by the satisfaction or disappointment displayed by the shikaries as a result of their visits.

As a subsidiary source of revenue, it may become possible to catch young ones of certain animals alive for sale to zoological gardens.

Conclusion.—This method of preserving wild life by permitting it to be shot on a very conservative scale and at high expense, only afforded by the very rich and keen shikaries, seems to be the only means of financing the Sanctuary. Besides, this proposal really aims at restricting the removal of animal life to narrow limits, at a rate slower than the estimated rate of multiplication of the species; and as such, it will secure, in effect, the preservation of the species, and poaching will automatically be eliminated. Such restricted shooting also provides against the possibility of certain species proving a nuisance to the dwellers in the vicinity of the Sanctuary, owing to their rapid multiplication under protection.

The possibilities of this suggestion therefore deserve serious consideration of all true supporters of preservation of wild life.

A WOODEN PILLAR 1,800 YEARS OLD.

BY S. R. DAVER, CHIEF FOREST OFFICER, BASTAR STATE.

In 1921 a wooden pillar was found with an inscription in Brahmi characters of the 2nd Century A. D. in a village called Kirari in Bilaspur District, Central Provinces. The pillar is made of *bijasal* wood (*Pterocarpus marsupium*). The details of the inscriptions and the history of the pillar are fully described by Rai Bahadur Hiralal in his book called "Inscriptions in the C. P. and Berar."

For the benefit of those readers of the *Indian Forester* who are interested in antiquities, I can not do better than to quote the Inscription No. 214 and footnote thereon from Rai Bahadur Hiralal's valuable and interesting book :—

"(214) Kirari[1] wooden pillar, Brahmi inscription.

1. There is an old tank here known as Hirabandh. In 1921 A. D. it partially dried up, which gave an opportunity to the local cultivators to dig up its silt for manure. In that operation they hit upon a wooden pillar 13′ 9″ long surmounted by a solid *Kalasha*. They to k it out and perceiving some letters on it called on the local school master to read it. Failing to make it out Lakshmidhar Upadhyaya had the good sense to take a careful eye-copy of it and brought the matter to the notice of Pandit Lochan Prasad of Balpur, the nearest person interested in antiquarian remains. The latter promptly brought the matter to the notice of Sir John Marshall, Director General of Archæology, under whose instruc-

(Deposited in the Nagpur Museum.)

Kirari is a small village 10 miles west of Chandarpur, which is 18 miles from Raigarh, a station on the Bengal-Nagpur Railway. Here a wooden pillar was found with an inscription in Brahmi characters of the 2nd Century A.D. The writing was much damaged by its exposition to the sun. yet Dr. Hiranand Shastri made out a number of names and their official titles, some of which find a place in Kautilya's *Artha Sastra.* Those that are still intact on the pillar are Nagararakhins (City guards or Police Inspectors) named Virapalita and Chirgohka. Senapati (Commander of the Army) named Bamdeva, Pratihara (Door-keeper) named Khipatti, Ganaka (Accountant) called Heasi, A Naga, Gahapatiya (keeper of the household fire) named Charika. Bhandagarika (Storekeeper) called Asadhiya, Hatharoha (Elephant Driver), Asvaroha (Horseman or Superintendent of Horses). Padamulika (Temple attendant). Rathika (Superintendent of chariots), Mahanasika (Kitchen Officer), Hathivaka (Superintendent of elephants). Dhavaka (Herald), Sauganadhak (Officer of perfumery), Gomandilika (Officer in charge of cows or cattle), Yanasalayudhagharika (Officer in charge of carriage shed and armoury), Palavithida (ka) Palika (Inspector of meat stalls), Lehaharak (letter carrier), Kulaputraka (perhaps Chief architect) and Mahasenani or Commander-in-chief. The mention of all such persons of rank would show that the pillar must have been set up in connection with some extraordinary ceremony performed by a high personage, who was in all probability not less than a great king of renown, whose name is now cast into oblivion. In the eye-copy a name like Siddharaja occurs which may have been the name of the king, but as yet nothing of him is known historically.

(*Epigraghia Indica*, Volume XVIII, pages 152 ff.)"

tion the pillar which was exposed to the sun thereby causing cracks which carried away some letters was again immersed into the tank until the arrival of Dr. Hiranand Shastri, Superintendent of Archæology, Patna (now Government Epigraphist for India), who deciphered it. It was finally removed to the Nagpur Museum by Mr. Abdus Suboor, Coin Expert, by order of the Director General. The portion without any letters has now been cut off. This find is the first of its kind yet made in India. The pi lar is made of *bijasal* wood (*Pterocarpus marsupium*), and is not less than 1,800 years old.

[We have been informed by Khan Bahadur Mohd. Sana Ullah, an officer of the Archæological Department at Dehra Dun, that there was no doubt about the age of the inscription, which has been assigned to it by Dr. Hiranand Shastri, on paleographical principles. The antiquity of the object, *i.e.*, 1,800 years, was therefore obvious.—*Ed.*]

PANTHER HUNT BY A PACK OF WILD DOGS.

BY N. P. BHARGAVA, RANGE FOREST OFFICER, YAWAL.

Mr. Kushalappa's note on "Panther's claw in wild dog droppings," in the *Indian Forester* for December 1930, induces me to furnish an instance of occular proof to show the supremacy of a pack of wild dogs over a panther, which might throw more light on the subject and provide some interest to the readers as well.

One morning I happened to be out on marking work in the Sahyadris. The batch of coolies had proceeded ahead and I was following them. My way lay along the contours of a steep hill which had a deep ravine below and facing it another hill with a flat base. Thus bound on an adventurous mission I had not advanced far in the valley when all of a sudden unpleasant roars of a panther, on the other side of the ravine, surprised me. My hairs were on end as I was completely unarmed. However, the prospects of some unusual scene aroused my expectations to the highest pitch. As I looked back I saw a full-sized panther running at full speed with all its might and force that it could muster, pursued by a pack of wild dogs. It was a fine point-to-point race.

The herd of dogs consisted of about 50 brutes, small in size but ferocious. The chase was, to my *astonishment*, in a moment interrupted as the panther, with a loud yell, took a desperate leap and got itself perched on the fork of a teak tree 10 feet from the ground. But this would not dissuade the pursuers. The army of dogs was obstinate. They at once besieged the tree and formed themselves in a circle around it looking at their favourite meal "Mr. Spots." The bright prospect of a delicious meal kept the dogs all the more restive and uneasy.

The poor panther waited in vain for some time on the tree with some hopes of deliverance, but it was not to be. The dogs wanted a meal and the panther had to provide it. At last the panther took a final chance of escaping and with that determination it took a fine long jump followed by a brisk race. The pack of dogs was not a bit behind and it also resumed the hot chase immediately

and before long overtook the panther. At a furlong's distance there was a terrible groan and in a few minutes there was perfect silence.

After an hour an examination of the scene revealed the marks of struggle and final division of the panther's skin by the dogs. A few torn pieces of the skin alone had been left over there to tell the grim tale of the tragedy that involved the life of an unfortunate panther.

I had the privilege of having enjoyed a full view of this "shikar" by wild dogs rarely to be seen. It would show that wild dogs, in a body, can exterminate any game from the forest once they visit it. Of course their collective strength against a tiger has not yet been ascertained but their indomitable character gives room for that supposition as well.

It is believed that wild dogs relish a panther meal and so no sooner do they get a scent of it, they set out in big packs for its hunt.

ABNORMAL FORMATION OF WOOD IN CYPRESS.

By G. B. F. Muir, I.C.S.

The southern slopes of Cheena, the hill guarding Naini Tal from the north, are clothed with a forest of cypresses—tall, slender trees, straight as arrows. The single stems are tapering cylinders with a cross section which in normal trees is perfectly circular. The rather drooping branches which never attain great length or thickness also seem circular in cross-section so far as one can discover from the ground. Seen against this background of uniform symmetry, the tree which inspires this note roused my curiosity.

The history of the tree seems clear enough. It was once, until perhaps forty or fifty years ago, a normal tree. Then some catastrophe removed the whole of the stem nearly to ground level. The remains of the stump, still clearly visible, show that the stem was then about two feet in diameter. All that was left of the tree was the roots, a stump almost flush with the hillside on the upper side and

a branch extending outwards over the khud. This branch must then have been at least ten feet long. When the rest of the tree was removed, a growing point ten feet out along the branch assumed the functions of the vanished apical point and started growing into a normal vertical stem. This stem is now over thirty feet high with a circumference at the bottom of 31 inches. It is perfectly normal in every way with the exception that instead of being directly above the point of attachment to the roots, its axis is ten feet horizontally from that point. In brief the whole trunk now consists of the stump, a horizontal portion formed out of the one branch left after the catastrophe, and the new vertical stem.

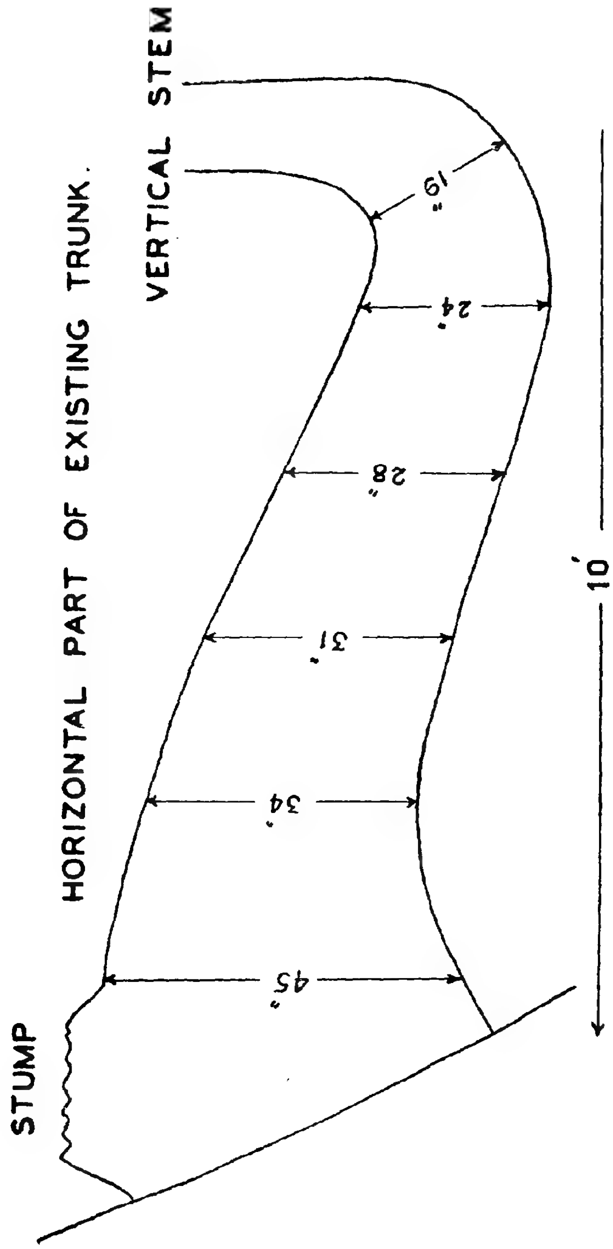
There is perhaps nothing very remarkable about all this, unusual though the case is. The interesting thing is the cross-section of the horizontal portion. The original branch was presumably cylindrical but instead of preserving that shape nearly the whole of the increase in cross-section has been in the vertical direction. Transversely this part of the present stem is nowhere more than six inches thick, but the vertical axis of the cross-section is three feet nine inches at the stump end diminishing gradually to about two feet near the new vertical stem. The diagram on next page will make the position clear, it being remembered that throughout its length the horizontal portion of the stem preserves a constant transverse thickness of six inches or perhaps a shade less.

It seems reasonable to attribute this remarkable departure from the normal cylindrical shape to the stresses gradually set up by the growth of the new vertical stem. These stresses must now be enormous. I imagine that an engineer who had to design a solid beam of the same material to withstand the same stresses would evolve something of very similar shape and proportions ; and if trees could be credited with intelligence one might well describe this tree as having displayed wonderful ingenuity in adapting itself to conditions which not one in ten thousand of its fellows ever has to face. But trees are not intelligent and so it must be a case of mere mechanical reaction which moreover is presumably functioning

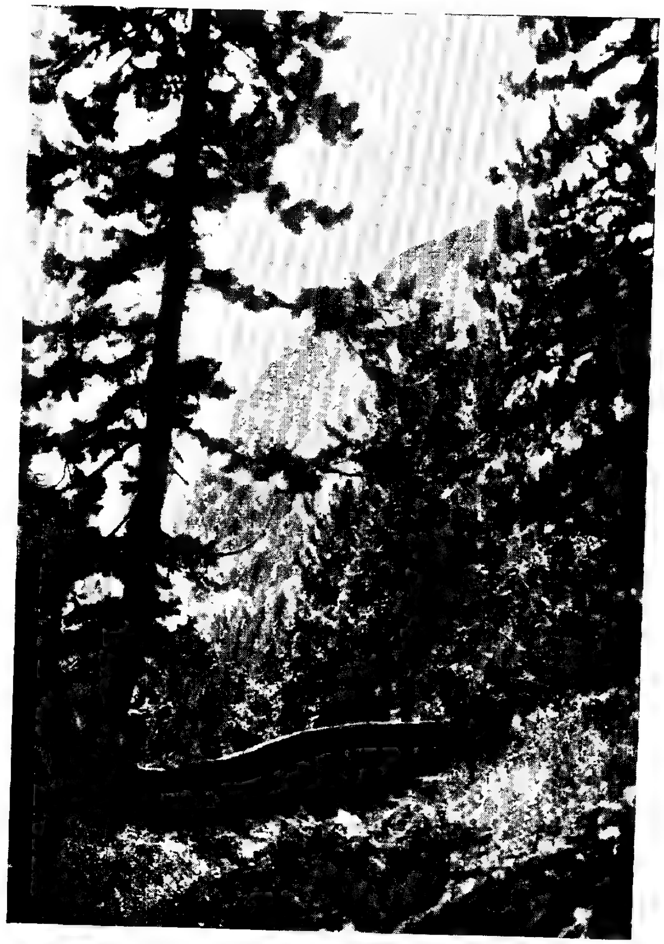
constantly in all cypress trees. It would be unreasonable to suppose either that this particular tree has an exceptional constitution or

DIAGRAM

SCALE 1" TO 2'



FORMATION OF WOOD IN CYPRESS.



First Tree.

First Tree (Fore shortened).

conversely that all cypress trees possess a latent capacity which only a very rare accident can rouse into activity. But if so, what is the mechanism through which the reaction is effected ?

This is a question for the plant physiologist and I have not the slightest idea what the answer is, nor do I suppose that an explanation of the answer, if there is one, could be made intelligible to a layman like myself. Yet though I cannot answer this question I can at least hazard a suggestion as to the nature of the stimulus by which the mechanism, whatever it may be, is set in motion. There is more to be learnt from this tree than mere measurements reveal. An examination of the horizontal part of the trunk shows that the bark has more or less perished along the upper edge, is smooth and of ancient appearance along the upper half of the sides, but is rapidly cracking and splitting off in strips on the lower half and particularly along the lower edge where its fresh appearance contrasts very markedly with that of the bark on the upper half. I think that no one who examined this tree would doubt that formation of wood is going on actively only on and near the lower edge. In the upper half the wood-forming layer is evidently dormant, perhaps moribund. Now the stresses to which the horizontal part of the trunk is subject are of course a couple, tension along the upper edge and compression along the lower. From this it seems a natural inference to argue that the formation of wood is stimulated by compression and is inhibited by tension or possibly by the mere negative absence of compression.

This phenomenon, if it is a reality, seems of interest theoretically, but might conceivably also have some practical application if present in species producing valuable timber. I do not suggest that we shall see forest officers going about loading trees with ballast in order to stimulate an increase in girth. All that I mean is that the thing may be one of the factors determining the optimum spacing of trees. The idea suggested is that too close spacing may prevent the development of a crown large enough to exert the degree of compression needed to produce a desirably stout stem. There are, however,

obvious difficulties. The mere dead weight of the crown, not multiplied by leverage, though permanently acting could set up only a small fraction of the stress existing in the tree illustrated. Moreover, even this stress would be distributed over the whole cross-section of the trunk and not concentrated near the wood-forming layer which alone is capable of reaction. Much stronger stresses, being multiplied by leverage, would of course be set up when trees are swayed to and fro by the wind. These would vary with the development of the crown and the resistance offered to the wind, but here again not merely would these stresses be momentary but since for each side of the tree they alternate from compression to tension and back again, the effect of the stresses of compression would presumably be negatived by the intervening tensions. Myself I imagine that the supposed effect though possibly always present would be found a quite negligible quantity in comparison with those of other factors determining the rate of wood formation. The speculation has however interested me and so I have set it down.

It may be objected that all this is a very pretentious edifice to erect on the evidence of a single tree. Why not dismiss the case as a mere accidental freak of nature? I do not think that any one who examined the tree would take this view; still I saw the need for corroboration and kept my eyes open for a parallel and in time I found one, though so far only one which is unmistakably an instance of the same thing.

This other tree—also a cypress—has a different history. It is growing out of a slide of shale which must have a constant set down hill. When the tree was very small the shale evidently began to push the stem outwards from the vertical. The apical point, seeking the vertical, kept changing direction relatively to the axis of the stem. The process continued until the tree was about 20 feet long by which time the stem at the bottom was nearly down to the horizontal and thence curved upwards in an arc with a radius of about 20 feet extending through about 80 degrees. The tree then succeeded in anchoring itself firmly and proceeded to develop a normal vertical

stem, the axis of which as in the other case is at a considerable horizontal distance from the point of anchorage. The distance in this case is even greater and I estimate it at about 15 feet. Thus similar stresses are set up but they have been acting of course not on a mere branch but on the original stem which being stronger had less need of special adaptation. Doubtless for this reason the departure from the normal circular cross-section is less in degree. It is however quite obvious, and as in the other case the bark along the upper edge of the nearly horizontal part is decaying, while active formation of wood seems confined to or near the lower edge. The transverse thickness near the root is about one foot ; while the vertical depth at the same point is two feet and three quarters. The height of the tree is now somewhere about 50 feet.

[Mr. Seaman agrees that nature does make provision for extra strengthening where such strength is needed such as the down hill side of trees growing on steep slopes subject to snow pressure.—Ed.]

METHODS OF MANAGEMENT IN THE MIXED DECIDUOUS TEAK-BEARING FORESTS OF KANARA, BOMBAY PRESIDENCY.

By E. A. Garland, I. F. S., Working Plans Officer, Dharwar, Bombay.

PART I.

It is probable that there has been an export trade in timber from these forests by sea since very early times. In the bad old days, when the country was split up into many little kingdoms, and the kings were perpetually at war, horses for the armies were imported in large numbers by sea. The products of the country being chiefly spices, it is likely that the returning traders took timber with them, as well as spices and rice, if only in order to ballast their ships. Eastward also there must have been some demand from the dry tracts of the Southern Mahratta country. But, even in peaceful times, the configuration of the district must always have placed a considerable check upon the volume of the timber trade, and it is to this fact probably that the value of the forests, which exist to-day, is almost

entirely due. The principal teak-bearing forests are on the eastern, and leeward, side of the ghats, which run parallel to the coast, and about 50 miles from it. The south-west monsoon, as it sweeps in from the sea, bursts in full force upon the crest of these ghats giving an annual rainfall of from 100 to 200 inches. Nature's response to this is dense evergreen (rain) forest. Eastward of the ghats' crest rainfall diminishes rapidly and within about 20 miles is no more than 30 to 50 inches annually. Here the forest growth also dwindles. *Anogeissus latifolia* is a prominent constituent and with some *Terminalia tomentosa*, but especially with teak, forms forests, generally well stocked but rather stunted, incapable of producing large timber. It is between these two extremes that the really productive forests are found. Teak, *Dalbergia latifolia*, *Terminalia tomentosa*, *Adina cordifolia*, *Xylia xylocarpa* especially on the wetter sites, and *Pterocarpus marsupium* especially on the drier sites, together with many other species grow to a large size. But this is only in a narrow belt, running from north-west to south-east, which is cut up in every direction by numerous streams and by several rivers of considerable size. In fact it is only on the central catchment areas of these rivers that the best teak occurs. Unfortunately rapids and outcrops of rock make the floating of timber an extremely precarious business, possible only with the aid of elephants. In the south the Bedti river follows a fairly direct course, south-eastwards, towards the sea, dropping over the ghats by some rather impressive falls. But in the north the topography is excessively confused. The district here is tucked away eastward of the Portuguese territory, Goa, the eastern boundary of which runs along the top of the ghats. On these ghats the rivers Pendri, Kalinadi, and Kaneri rise, and flow at first nearly due east. The two former join and then begin to turn until they flow due south. Finally, turning straight back westward, meeting the Kaneri, they go out into the sea at Karwar. All these changes in direction are executed within an area of less than 20 square miles and it is within this same area that the best of the teak-bearing forests are found. Throughout the rivers flow between deep banks, but as their course turns from south to west, these

develop into a gorge of most imposing dimensions, which cuts right through the ridge of the ghats. Thus, although the principal teak-bearing forests of Kanara are actually situated eastward of the ghats, they would be more accurately described as being in a series of pockets scooped out from, and sheltering behind, the ridge. Doubtless originally there was also much teak in the forests on the flatter, more accessible lands below the ghats. But most of this was worked out in very early days and only recently is being replaced in series of plantations.

It is recorded that when the *British acquired supremacy*, it was almost literally true that, owing to the conduct of the Sonda Chief in particular, and also of Mahratta freebooters, there was little to govern except trees and wild beasts. The Kanara forests soon became prominent as a possible source of timber, especially for ship-building. From 1799 until about 1843 extraction, not conservation, was the sole object of management. At first concessions were granted to timber syndicates but in 1807 a proclamation was issued vesting in the East India Company the royalty rights in teak which had been claimed by former Governments. Thereafter the Company established a monopoly in export or even in exploitation for domestic use through their own agent, Captain Watson. This led to a public outcry and from 1823 the monopoly was relaxed, whereupon the more accessible forests were exploited so drastically that many of them were ruined and some even disappeared. Any distinction between Government or private forests seems to have been excessively vague. Unrestricted fellings were permitted as much in one as in the other. The inevitable result was that the available supply of really first class teak began to run short and prices rose to such an extent as to cause alarm. In 1843, the first efforts at conservation were made by revising the export tariff on teak. The actual duty remained unaltered at 5 per cent. by land and 8 per cent. for export by sea, but the valuation was so fixed that small logs from immature trees were valued proportionately higher. By this means, the duty on immature teak was substantially raised and the felling of such trees considerably checked. This only lasted until 1848, however,

when an Act (Act XVI of 1848) was passed abolishing all export duty on port-to-port trade in India and rescinding the restriction which the tariff of 1843 had imposed upon the felling of young trees. Other influences also were at work during this period which were adverse to forest conservancy. About 1847 Dr. Cleghorn induced the Commissioner of Mysore to stop the practice of *kumri* (shifting cultivation). As a result of this prohibition, there was a large influx of people from Mysore into Kanara, the practice having been taken up by all sorts of people of quite different classes from the jungle tribes who, preferring to live a roaming life, had lived in this fashion for centuries. The increase of population practising this form of cultivation seriously threatened the total ruin of the Kanara forests. In June 1864, the Collector stated that in the years 1854-55 to 1856-57 an average of about 8,000 acres was cleared annually. In 1857-58 to 1860-61 the clearance was 7,501 acres, 8,751 acres, 7,357 acres and 6,474 acres in the respective years. In 1861-62 the practice was suppressed, only 1,235 acres being cleared in that year and 154 acres in 1862-63. In 1863-64 *kumri* was again permitted by the Revenue Commissioner and 7,144 acres were cleared. In 1864-65 the Collector limited the acreage authorised for clearance to 4,270. Subsequently the practice was again suppressed. It was in 1862 that Kanara was transferred from Madras to Bombay, and it so happened that in that year the Bombay Government were reorganising and extending their Forest Department. Kanara was placed under an Assistant Conservator, and as part of the whole reorganisation scheme the issuing of unrestricted felling licenses was abolished. Thereafter all felling was to be done under the supervision and instructions of the Forest Department. A depot was to be maintained at Karwar, and three others along the inland borders of the forests, to which all timber was to be brought and periodically sold by auction. Government departments and others might have special requirements supplied at any time from these depots at 5 per cent. over the last auction rate. The Assistant Conservator was however directly under the orders of his Collector, while the Conservator, who had the whole Presidency in his charge, was merely

an adviser to the Collectors on technical matters. Orders issued by the Assistant to his Inspectors and Foresters were made through the Mamlatdars of the talukas. All the accounts of revenue, expenditure and budget were carried out in the Collector's office. To describe forestry as being under the control of a separate department is therefore incorrect. It had merely become a special branch of the Revenue Department. Matters continued thus until 1870 when, at the special request of the Bombay Government, Dr. Brandis visited the Presidency and made recommendations which gradually established the Forest Department on an independent basis.

The next two decades were devoted chiefly to general organisation, but silviculture was not entirely neglected. By 1871-72 fourteen plantations had been made in Kanara, covering 516 acres and containing 535,514 teak seedlings and saplings. Various experiments with exotics were also made. These plantations had been started in 1865-66 and their total cost up to March 1871 had been Rs. 51,296. Below ghats the principal plantations were at Kadra and Murdy, above ghats at Birchi. The last of these was greatly extended subsequent to 1871 and the neighbouring forests also became an annual training ground for selected inspectors and foresters in the art and practice of thinning. Teak selected for girdling were marked by the forest subordinates and appear to have generally been the best which could be most easily extracted. The number marked annually also seems to have depended on the anticipation of what contractors could fell, fashion and bring out in each fair season. After the logs were brought to the depots, they were sold by auction. Under such methods of exploitation naturally much unsound timber was left to accumulate in the forests. Since 1868 the need for a portable steam saw mill had been urged on Government and in 1874-75 one was obtained and set up at Kolikeri in what is now the Kanara Eastern Division. It cannot be doubted that this event had far-reaching effects upon the surrounding forests. No demarcation of any of the Kanara forests had yet been made, there was no Forest Act and of course no working plan. The building of a railway from Hubli to

Goa and the erection of cotton mills at the former place produced a substantial demand for sawn timber. By 1886-87 there were three mills, at Kannigeri, Kolikeri and Kirwatti, the two latter apparently devoted to preparing sleepers. There is ominous mention of wastage due to the small size of trees felled for sleeper production. In 1887-88 the Southern Mahratta Railway set up its own machinery for sleeper production and in the following year the Kanara mills were closed and sold. Thus ended what may be considered, in spite of plantations and some efforts to restrict felling to unsound or over-mature trees, as the period of unregulated exploitation. Although mills were again started in 1896 proper working plans were then being introduced whereby the fellings were definitely controlled.

Towards the close of the nineteenth century the sub-division of the teak-bearing forests into permanent blocks and compartments was carried out. Rides 30 feet wide were cleared to mark the boundaries wherever these did not follow existing cart-tracks, and at the corners of every compartment zinc plates were put up showing the block and compartment number. Thus the first essential for proper organisation, sub-division into convenient units, was accomplished. Strip enumerations were made of each compartment on a basis which varied from 3 per cent. to 8 per cent. and the first working plans were drawn up. These invariably followed the lines already made familiar elsewhere by Dr. Brandis, and prescribed what is now known as the Indian Selection System. The details differed, more especially in the calculation of the number of trees likely to come up to exploitable size during the first felling cycle, but the principle was always the same. Unfortunately in some cases the letter rather than the spirit of the system was followed and the exploitable size was apparently fixed more on consideration of the smallest size it was profitable to exploit than upon a careful appreciation of the proper proportioning of stock, above and below this limit, so as to maintain the yield in subsequent cycles. The minimum exploitable diameter was generally taken at 24 or 25 inches and the felling cycle at 24 years. Usually it was prescribed that the whole of the estimated number of trees above the diameter limit should be exploited during

the first cycle, as being fully mature or already over-mature, but sometimes they were to be spread over two cycles. For the calculation of trees likely to become mature during the cycle the rates of diameter growth of sample trees were taken, the proportion of trees in the lower diameter classes which would reach maturity was worked out on this basis, and the result, or some fraction of it, added to the number already deemed to be exploitable. The compartments coming under the plan were then distributed into annual coupes for the cycle in such a way that the number of trees to be felled each year was approximately equal. Thus, on account of the patchy way in which teak was distributed through the compartments, the annual yield, fixed in number of trees over 24 inches, might have to be taken from coupes as small as three or four hundred acres or as large as one or even two thousand acres. Management was therefore made difficult, and it also soon became obvious that silviculturally the fellings were not altogether satisfactory. In places their intensity might be very slight. Elsewhere, again owing to the patchy distribution of teak, something in the nature of a limited clear-felling might be made. Worse still no provision was made for the removal of unsound stock below the girth limit. Consequently improvement fellings were generally superimposed upon the original prescriptions, and however conscientiously the executive officers might endeavour to restrict these to the removal of genuinely unsound trees, dislocation of the original yield prescriptions was inevitable. Another unsatisfactory feature, which caused anxiety where Class II trees had been relied on to supplement those already in Class I in order to keep up the yield in the later years of the cycle, was the realisation that diameter bore extremely little relationship to age and that in many cases, especially where the teak was thoroughly over-mature, trees were in the lower diameter classes merely because they had become moribund at that stage, and would probably never grow up to the exploitable size. There was also a general fear that the exploitation of one species only out of these mixed crops, and that a light demander was not resulting in its natural regeneration in anything like the quantity required. Experiments were constantly

being made in artificial regeneration on open patches left after the felling, and especially where bamboos had seeded. In all these various ways deviations from the original plans gradually crept in, so that the operations actually being carried out bore little resemblance to those which the plans prescribed. Control became largely a dead letter. Revision was obviously necessary.

Embodiment of the alterations in management, which experience indicated as necessary under new working plans, was much delayed by the war of 1914-1918. Then the expansive ideas generally current during the next few years somewhat influenced the form of these new plans. It was believed that all sorts of timbers besides teak would be readily saleable at high prices and that, as a corollary, large increases of staff and intensive working would be justifiable. Clear-felling and planting on a large scale became the order of the day. Attendant upon this change of policy, two difficulties quickly arose. Either the annual plantation areas were so large that adequate labour and staff could not be concentrated sufficiently to cope with the rush of work during the critical period, or else felling series had to be so multiplied that supervision suffered. Thus while much very good work was accomplished, some of the results were perhaps not quite as remarkable as had been hoped. This however was a matter of organisation which could soon have been satisfactorily adjusted if the golden forecasts of revenue had been realised. But, alas, the markets for species other than teak failed to materialise and prices for teak also dropped steadily. The clear-fellings therefore soon involved high unremunerative expenditure. Teak, which almost alone out of the exploited crop produced revenue, formed only a small percentage of the whole, but the plantations which were replacing it meant crops of nearly 100 per cent. teak for the next rotation. The benefit to posterity would be immense, but its present cost was becoming prohibitive. The advance had been planned upon too large a scale and something less ambitious was required, if the present generation was to receive a fair share of financial benefit from these valuable properties. Another anxiety was the possibility of a critical period occurring, when the new regular crops

of teak were still not yet fully productive, but the unconverted crops would have dwindled to such an extent that revenue was likely to decrease. The new plans had prescribed complete conversion to regularity in one rotation and had fixed the yield by area without any volume check. They had also prescribed improvement fellings on cycles of about 20 years in the areas not yet taken up for conversion. Thus, though it was believed that the annual coupes or periodic blocks had been arranged so that there would not be any disastrous drop in yield during the middle years of the rotation, there was sufficient scope for doubt on the point to be uncomfortable. It has fallen on the writer to endeavour to evolve a method of management, which, while providing an adequate improvement in the more remote future, will insure financial benefits at present and in the near future, in reasonable proportion. The above is an attempt to summarise and learn from—but not to criticise wantonly—past endeavours and experiences. On these are based the writer's own suggestions for a possible solution of the problem. They have no official sanction, and criticisms of them will be welcomed.

PART II.

Certain valuable lessons emerge from the history of the past methods of management in these teak-bearing mixed deciduous forests of Kanara. These are both silvicultural and practical. Indeed, the first lesson is the inevitable failure of any form of management which sets undue emphasis upon either "practical" or "silvicultural" considerations. The two are indivisible. As Dr. Troup has pointed out, "the application of silvicultural systems presents problems of an essentially practical kind." (*Silvicultural Systems*: Introduction, page vi.) The converse of this statement is equally true. Practical problems create silvicultural systems. No system, however classic, has any virtue in itself, but only in so far as it produces in practice desirable results. In any normal forestry business the aim is to keep or establish the forest and land in the best possible condition in order to make the largest income. But the essential point is that, though probably no absolute finality in achievement is attainable, every step forward towards the ultimate objects of management must be perfectly balanced in all respects if real progress is to be made. In fact progress must be systematical, methodical, even though current conditions are too abnormal to permit any one of the classic systems being adopted in its entirety. It is just this nicely

adjusted balance in progress, the hall-mark of sound management, which so far has not been entirely satisfactorily accomplished. It involves the accurate appreciation of a thousand and one facts and factors, past, present, and future. Therein lie possibilities for endless arguments. All that can be done here is to state, rather badly, the writer's own conclusions and proposals.

The first conclusion is that in forests of this type where, so far as it is possible to judge, teak will always be the principal product, conversion to regularity, combined with a substantial increase in the proportion of teak, should be accepted as the ultimate object of management. Next that a satisfactory increase in the proportion of teak can only be attained by artificial means. This involves clear-felling and planting. Lastly that though the immediate attainment of regularity in one rotation is probably not practical, yet a substantial advance in that direction can be made within that time. Since the first two of these three conclusions are resultant chiefly from general facts and arguments, which will be familiar to all students of the fairly extensive literature dealing with the production of teak, there may be no need to dwell upon them. But since the third conclusion is based on considerations more particularly local in application, this requires some explanation.

In dealing with forests covering roughly 600 square miles and containing at least three quality classes of locality, any figures can obviously only be approximate averages. It may however be conceded on this basis that for plantation teak an estimate of 100 years to attain maturity may be fair. Also that it may not be unduly optimistic to anticipate that in the second rotation, 100 acres (one of which was clear-felled and planted in each year of the first rotation) would produce every year 20 to 30 fully mature teak as a final yield. In addition to this there might also be intermediate yields annually on something like the following scale :—

Cleanings in all plantations less than 10 years old.	400 *small poles doubtfully saleable.*
From 1 acre, given a 1st thinning in its	15th year, 250 small poles.
From 1 ,, ,, 2nd ,, ,,	30th ,, 150 poles.
From 1 ,, ,, 3rd ,, ,,	45th ,, 100 trees.
From 1 ,, ,, 4th ,, ,,	60th ,, 50 ,,
From 1 ,, ,, 5th ,, ,,	75th ,, 20 ,,

Certainly these subsidiary yields would gradually have been piling up while the conversion operations were still in progress, *i.e.*, during the 1st rotation. But, throughout the greater part of those first 100 years, for anything approaching fully mature timber it would still have been necessary to rely on the unconverted areas. For comparison with the above therefore we need to consider what is the existing stock. Full strip enumerations of 100 acres taken in two directions so as to intersect across each of 13 compartments, the compartments selected more or less at random but so as to cover all quality types of locality in Kanara Eastern Division, give the following average stock for 100 acres :—

Diameter in inches.	TECTONA GRANDIS.		DALBERGIA LATIFOLIA.		TERMINALIA TOMENTOSA.		Lagerstroemia lanceolata.	Pterocarpus marsupium.	Adina cordifolia.	Ougeinia dalbergioides.	Terminalia paniculata.	Anogeissus latifolia.	Xylia xylocarpa.	Jungle wood.
	Sound.	Unsound	Sound.	Unsound	Sound.	Unsound.								
4 ..	38	4	8	1	30	..	9	3	2	..	9	26	28	196
5 ..	39	6	10	1	37	1	12	2	3	1	13	38	42	231
6 ..	42	8	12	3	40	..	13	2	2	1	12	40	55	222
7 ..	35	9	12	4	45	1	13	1	3	..	13	35	44	147
8 ..	41	12	20	7	60	2	16	1	3	1	18	46	36	145
9 ..	36	10	19	7	56	1	10	2	3	1	13	36	44	100
10 ..	44	15	20	7	62	2	13	3	3	1	18	36	42	103
11 ..	30	13	17	6	36	2	9	2	3	1	11	22	29	60
12 ..	39	16	21	8	54	3	9	3	3	1	16	26	36	94
13 ..	34	13	17	4	44	2	6	3	3	..	10	18	26	53
14 ..	31	15	25	6	47	4	6	2	3	..	17	16	26	56
15 ..	31	15	18	7	42	3	4	3	3	1	10	13	22	50
16 ..	25	10	14	6	35	4	2	3	2	..	8	9	16	42
17 ..	15	8	11	3	25	4	2	2	2	..	8	5	13	25
18 ..	16	10	8	5	31	4	3	2	3	..	9	4	11	30
19 ..	13	7	7	2	24	4	3	1	2	..	8	2	8	20
20 ..	14	7	5	3	19	5	3	1	3	..	9	3	8	24
21 ..	6	3	4	1	15	3	2	1	2	..	5	1	4	14
22 ..	15	5	4	1	23	4	3	2	3	..	7	2	5	22
23 ..	6	2	2	1	9	2	1	1	2	..	4	1	3	8
24 ..	8	2	4	1	12	3	1	1	3	..	5	..	2	12
25 ..	5	2	1	..	12	2	1	1	4	..	6	..	2	10
26 ..	4	1	1	..	7	1	1	..	1	..	2	..	1	5
27 ..	2	1	1	1	7	1	..	..	2	..	2	..	1	4
28 ..	2	1	1	..	7	1	1	..	2	..	3	..	1	6
29 ..	..	..	..	..	3	1	..	..	1	..	1	..	1	1
30 ..	1	..	..	..	5	2	..	..	3	..	4	..	1	4
31 & over.	1	..	1	..	11	3	1	1	18	..	10	..	1	10
Total	573	195	263	85	798	65	114	43	87	8	251	379	508	1,694

The forests in Kanara Northern Division are undoubtedly better than this and contain a very much higher proportion of teak. It is however for Kanara Eastern Division that the working plan revision is at present in hand. Divide the above stock among 100 coupes of one acre each, make every possible allowance for trees reaching maturity and therefore becoming exploitable in the coupes not yet due for conversion, and still the two sets of figures for teak in the 1st and 2nd rotations, during and after conversion, cannot bear comparison with each other. However carefully we nourish such stock, even making every possible allowance for yields which should be coming in from the earlier plantations, a phenomenal and more or less sudden increase in production of teak would be difficult if not impossible to avoid. A particularly unsatisfactory part of the position would be that all allowances made for probable production from the plantations must be largely a gamble and their economic justification might very well be more than doubtful. In fact, wholesale conversion by clear-felling and planting would not allow a proper balance between the two rotations. It must therefore be condemned for that reason alone. But there are also important silvicultural objections to such procedure.

The technique of plantation work with teak has now been brought to a stage at which a very high percentage of initial success can be guaranteed. But on some sites subsequent stagnation, resulting even in almost complete disappearance, has been found to occur for reasons, which though obviously originating in adverse soil conditions are not yet fully understood. This has even been found to occur where the original crop was apparently growing under satisfactory conditions. At other places clear-felling is obviously inexpedient. Examples are outcrops of laterite or of sheet rock at or near the surface : a marked tendency to water-logging, which would certainly be increased by wholesale removal of the existing crop (probably nearly pure *Terminalia tomentosa*): dense undergrowth of young bamboos, especially *Bambusa arundinaceæ*, the regrowth of which is a potent cause of suppression to young teak, very difficult and expensive to keep in check; blanks or areas carrying scattered pole growth which

are in ecological phraseology—in a secondary progressive sere, following upon retrogression caused in the past by excessive grazing, by constant fires, or more frequently by shifting cultivation. Even under the most favourable circumstances clear-felling must always be a drastic treatment, silviculturally through soil exposure, economically through felling much immature timber. *Here in each and every* compartment (approximately 600 acres, the working unit) there is complete irregularity, not only in age but also in site condition. The stock is in all stages of development towards maturity, partly as the ordinary consequence of what may be described as normal natural regeneration, on sites where soil conditions are normal for forest crops. But over considerable areas there is immature stock, which is abnormal in origin, having arisen only in response to recent changes in the soil, which might again be very easily upset. The conclusion is therefore that for these forests the application of clear-felling must be definitely selective and that it should be limited to about one quarter, or at most one-third, of the whole area.

A corollary of the above is the question of how the remaining three quarters, or two-third, should be treated. One possibility is to continue the so-called Indian Selection System, making a separate Conversion Circle of the areas chosen for clear-felling. This is considered to be quite undesirable. A more concise and conclusive condemnation of the "Indian Selection System," as a method of management, could not be compiled than that made by Dr. Troup on page 748 of Volume II of his "*Silviculture of Indian Trees.*" To continue it in the present case would limit all advance towards the ultimate object of management—*the establishment of regularity*—to the Conversion Circle. The principal advantage of separating the latter would lie in making it compact. Here, as has already been explained, such an arrangement would not be practicable, because sites suitable for clear-felling are scattered indiscriminately and of all shapes and sizes. Moreover, if only on account of bamboos seeding, it would only be possible to choose the annual coupes for at most about 20 years in advance. Arising out of this and of the fact that provision

for the whole yield of teak in the 2nd rotation can be made in the Conversion Circle alone, whereas any form of Selection System presupposes the requirement of a sustained yield of its own continued indefinitely, difficulties in regulating the yield would inevitably occur, which need not be explored in more detail. The alternative is to work on a basis of periodic blocks in which a fixed proportion of the existing stock will be replaced by clear-felling and planting with teak ("planting" of course includes regenerating with sown seed, transplants and/or stump planting), and the remainder renewed by natural regeneration of mixed species, stimulated by felling out the existing crop, as a combination of silvicultural principles and economic conditions may permit. This last qualifying clause may seem unsatisfactory and vague. An expanded explanation will be given in due course. The method appears to offer advantages which can best be demonstrated by briefly detailing the whole suggested procedure, in order, from the beginning.

The entire area would be roughly divided into working circles, on a broad basis rather of possible potential productivity than of present crops. By this is meant that areas at present degenerate in condition, occurring within an area of high rainfall, would not be thrown out of the working circle into which the surrounding areas would be put, on a long rotation, to be classed with areas of low rainfall on a short rotation. Each working circle would be divided into felling series, if necessary for convenience of work, and the only distinction between the circles would lie in the provisional lengths of their rotations. These rotations would be based on the estimated rate at which plantation teak might be expected to reach maturity, 120, 105 or 90 years. The calculation in the present state of our knowledge could only be approximate. But each rotation should be a multiple of some fixed period, for which 15 years is suggested, each felling series being therefore capable of division into 8, 7 or 6 periodic blocks, according to the working circle to which it belonged. This would allow the whole plan to be revised throughout at the end of each period. The division into working circles and felling series fixes

the area available for each periodic block, which should be adhered to as far as is reasonable considering the approximate nature of the premises. It should therefore generally be possible to take whole compartments for forming a periodic block. By distinguishing between working circles on a basis of quality class the need to introduce height into calculations for yield may be obviated. This will eliminate one way by which error may be introduced. It will also allow the yield to be stated in square feet instead of cubic feet, an advantage because the former is derived direct from diameter or girth measurements and can be readily converted back into them when annual coupes are being marked for felling.

The area basis of the periodic blocks having been fixed, the volume check is arrived at by 10 per cent. enumerations of each compartment in inch diameter classes, done in two or more intersecting strips. From these the total breast-height area of teak in each felling series can be calculated. Subsidiary species may also be enumerated as considered desirable, but for the present the yield can be taken entirely on teak, for which alone a stable market exists. The question now arises: what proportion of the stock of teak in each felling series can fairly be taken out during the first period, wherefrom, and in what form? We can reckon that increasing quantities, first of small poles, then in larger sizes, will become available during the first rotation from the thinnings of plantations converted to complete regularity. It is therefore reasonable if possible to arrange for a diminishing yield from the whole area under conversion, *i.e.*, from the current periodic block plus those blocks not yet taken up. A difficulty occurs here in that while the "intermediate" yield from thinnings will increase from time to time, as 2nd, 3rd and 4th thinnings become due, at a compound rate not only in volume but especially in value, the writer has not been able to evolve as yet any method of diminishing the "final" yield other than in equal amounts period by period. This is a definite flaw in the proposals. For want of a better idea however it is suggested that the yield during each period should be the same fraction of the total stock of the felling series as the period is of the rotation, plus the amount by which the remainder of the stock can be discounted so as

to offset the increment put on by this remainder during the period. If the calculation can be correctly made the first part will remain constant for every period while the second, assuming that the rate of increment stayed steady, will diminish period by period by the same amount, there being the stock of one periodic block less to discount as each one is taken up for conversion. Then in a felling series on 120 years' rotation, divided into 8 periods of 15 years each and containing a stock of teak totalling Y square feet in area at breast height, for which from data available the rate of increment is calculated to be 2 per cent., the yield for the first period would be :—

$$\frac{Y}{8} + \left(\frac{7Y}{8} - \frac{7Y}{8} \times \cdot 743^*\right)$$

and for the 2nd period :

$$\frac{Y}{8} + \left(\frac{6Y}{8} - \frac{6Y}{8} \times \cdot 743^*\right)$$

*Derived from the present value formula.
$C^{c} = \frac{Cn}{1 \cdot 0p^{n}}$ see Schlich's Manual, Volume III, Appendix III, page 349.

If there was to be no drop in yield therefore during the 2nd period, the intermediate yields from the plantations established during the first period would have to equal or exceed $\frac{Y}{8} - \frac{Y}{8} \times \cdot 743$. We can get a rough idea as to what this requirement will amount to by substituting for Y the figures for the average 100 acres previously given. In sound teak alone the stock amounts to 531·3 square feet. The discount rate on 100 acres would therefore be 531·3—(531·3 × ·743) = 136·6 square feet. But since for every 100 acres put into periodic block I, we propose only to plant up 25 acres, the intermediate yield required during the 2nd period would be $\frac{136 \cdot 6 \times 4}{100}$ or 5·46 square feet per acre, which is well within what can be expected. Actually however it is improbable that the calculated rate of increment will be precisely correct. Rather more or rather less than the exact proper proportion of stock will be left at the end of the period, in consequence of the rate having been calculated rather too low or too high. But this can be adjusted without difficulty at revisions at the end of each

period, and at the same time as data for this accumulates, and therefore becomes more accurate, so also the possibilities of the plantations will become known. There are several methods of calculating the increment which may be adopted (*cf.* Part II of the paper by Ishwar Das Mahendru on Statistical Research in Irregular Crops on page 197 of the Proceedings of the 3rd Silvicultural Conference, 1929 ; also the Statistical Code, page 101). So long as the calculation is made on a fairly conservative basis there is always in reserve for later periods the increased subsidiary yield from older thinnings. Absolute accuracy in the calculations for the earlier period is therefore not essential.

The yield of teak for the 1st period having been thus decided there remains for consideration where it should be taken and in what form. Obviously, with these highly irregular crops, all the stock of teak which is ripe for exploitation will not be concentrated on an area sufficiently small to go into the first periodic blocks. It will therefore be the duty of the compiler of the working plan to distribute the yield for the period as his inspections and the results of the 10 per cent. enumerations of each compartment indicate. For each compartment from which he decides that trees should be removed because they have ceased to put on satisfactory increment, either on account of over-maturity or unsoundness, the number of square feet from unsound trees and from those of large diameter can be worked out from the enumerations. How far these figures should be accepted as a definitely fixed yield to be strictly adhered to, or only as a guide for the marking officer and for control purposes, experience will show. From compartments destined for inclusion in the first periodic blocks the whole stock of teak with increment for half the period would count against the yield. The adjustment of the total yield for the period between compartments inside and outside the current periodic blocks will require some skill. But the guiding rule would be that, so long as there was a reasonable likelihood of the rate of increment remaining satisfactory, stock outside the current periodic block should be allowed to accumulate in the largest sizes so as to obtain price increment. It might also help the allotment if compartments sufficient to form

Periodic Block II were provisionally selected to be left entirely untouched. When the compartments to be worked outside Periodic Blocks I had been chosen, they would be distributed to the years of the period so as to keep the annual yield from this source fairly level.

The annual yield from the Periodic Blocks I will be 1/15th of the total quantity of teak in each. Full enumerations might be made to insure complete accuracy. The method of working in No. 1 Periodic Blocks of all felling series will be that, annually, first the fixed area to be clear-felled for teak plantations will be selected. This annual quota, though amounting to about ¼ or 1/3rd for the whole plan area, may vary in different felling series according to the suitability of conditions. Generally the proportion will be higher in the wetter areas, since plantations thrive better and promise greater value there. The executive officer will be left quite free in his choice of sites for plantations within the Periodic Block I. Having ascertained the yield of teak from these clear-fellings (in square feet) he will then proceed to mark a regeneration felling in adjoining areas of the periodic block until he completes his total annual yield. Though the annual yield should never be exceeded, except perhaps for a small fixed percentage of difference allowed either way so as to straighten out the boundaries of the annual coupe, the area off which it is taken, added to the plantation area, may be greater than 1/15th of the total area of the block. On the other hand it must never be less. This means that if the annual yield of teak is reached off too small an area, the deficiency must be made up by taking into the annual coupe non-teak-bearing parts of the periodic block. The reason for allowing a larger proportion than the correct 1/15th to be worked over in any year is because it may not always be silviculturally desirable to remove all the teak in the first regeneration (or seeding) felling. It is in the marking of these fellings that the executive officer will have great scope for displaying skill and forethought. Though his object is to obtain a more or less even-aged crop of mixed species, young poles will always be kept and assisted. The more mature stock even would not necessarily be removed at once. As previously remarked, silviculture and market conditions both must receive consideration.

All through the period the executive officer will be returning to tend, clean and thin his teak plantations, and at the same time he can continue to open out further the surrounding mixed crop if he can sell the timber. Actually it will probably not be possible to exploit the whole crop. But at worst most of the oldest constituents will have been removed, and the young ones will have been greatly increased. At the end of the 1st period of 15 years in all felling series, periodic block I will consist partly of a set of teak plantations, aged 1 to 15, in which complete regularity will have been established, and partly of mixed crops in which some degree of irregularity will remain, but of which the average age will have been greatly reduced and will approximate fairly closely to that of the plantations. Finality in this matter will not necessarily have been reached even at the close of the first period. Opportunities may arise later, when thinnings are being made in the plantations, to do similar work in the naturally regenerated portions of these earlier periodic blocks. The effect of this will be to remove many of the stems which spoil the general regularity. Thus, when each felling series has been completely worked over, the actual average age of the entire crops in each periodic block should, therefore, be of genuine significance as regards their re-approach to maturity.

PLANTATION NOTE ON OUGEINIA DALBERGIOIDES IN BONAI STATE (ORISSA)

By H. Sen Gupta, Assistant Forest Officer, Bonai State.

1. Artificial regeneration of *Ougeinia dalbergioides* is not common in Bihar and Orissa and according to the Bihar and Orissa Forest Bulletin No. 1 of 1929 " the propagation of this species is not easy." An experiment on the artificial regeneration of the species was commenced in Bonai State in 1926 under the direction of Mr. H. F. Mooney, I. F. S., the then Agency Forest Officer, and it has met with success—the average height and diameter of the plants in the eighth year are 15 feet and 4 inches respectively. So a few words in connection with the raising of the species, as experienced during the first eight years, may prove of some interest,

2. The plantation site is on open waste land of an abandoned forest village and the soil is of decidedly poor quality, presumably having lost most of its fertility by cultivation of field crops. The plantation area is five acres. It is situated about 1,700 feet above sea level and is on slightly sloping ground with an easterly aspect. The average annual rainfall of the locality is 68″ most of which falls between the period 15th June to 15th September. Frost occurs occasionally during the months of December and January.

3. Seeds were sown in the two following ways: –

(*i*) IN PITS. The pits (18″×18″×18″) were spaced 6′ × 6′ and dug a month prior to sowing so as to ærate the soil. Leaf mould was then mixed with the soil and the pits filled in. Three unsoaked seeds were sown in triangular formation, 3″ apart in each pit.

(*ii*) ON RIDGES.--The ridges were prepared by ploughing the ground to the depth of nine inches. The ridges formed were about 3′ apart and 6″ high and the seed was sown on them at intervals of one foot.

In each case sowing was done at the advent of the monsoon. Germination commenced within a fortnight and was complete in another 10 days. During the first and second years the plants were weeded twice annually in September and February. The second weeding was followed by æration of soil within a radius of 18″ of each plant. More than 60 per cent. of the plants died back during the first winter but in the following spring there was a characteristic sprouting of more than one shoot from each stump. This dying back may be attributed to the effect of frost to which the species is susceptible during its early youth. Most of the subsequent shoots survived and gave the plantation the appearance of a coppiced area. This phenomenon would of course be of rare occurrence in natural forest under normal conditions, though the species reproduces profusely by root-suckers.

There were casualties of about 15 per cent. in the pits and 20 per cent. on the ridges, due to the effects of drought. The casualties were replaced in the following July. To protect the plants from

drought they were watered from time to time during the hot weather, and this undoubtedly saved many.

Weeding was stopped from the third year and, except for æration of soil round weak plants, practically no further cultural operations were carried out in the plantation till the sixth year when in February congestion was relieved by the removal of superfluous leaders and by the pruning of lateral branches. The pruned surfaces were painted with coal-tar to avoid the attack of fungus. The canopy is now completely closed and in order to promote better bole development it is proposed to carry out mechanical thinnings when the average diameter growth reaches about six inches.

The usual twisted and crooked growth of the species is markedly absent from the plantation. The growth in the pits is a little better than that on the mounds. The maximum height and diameter growths are 26 feet and 6 inches respectively.

The plants have had to strive against many enemies. Besides being browsed by cattle and deer they have been attacked by rats and white-ants. In the early stages, up to the third year, the rats made a clean cut at ground *level* and ate away the whole root system—they have a special liking for this species whereas they never touch plants of *bija* (*Pterocarpus marsupium*) or *gambhar* (*Gmelina arborea*). White-ants were observed to harm the plants at a more advanced stage, (during the seventh and eighth years), by attacking the roots and gradually ascending the stems.

In conclusion it would probably not be inopportune to mention the reason for starting the experiment of planting this species. During the period from 1918 to 1927 the demand for the timber of this species in Orissa was in excess of the supply available and the price in 1925-26 rose as high as Rs. 4/- a cubic foot in the round. The species is also a good lac host and at that time the lac market was at its highest. In future along with industrial development in India there is every possibility of an increased demand for this timber especially for machinery parts such as looms. So it is worth while considering the planting of the species on a larger scale.

Note from Silvicultural Branch, Forest Research Institute.

Experiments with the artificial regeneration of *Ougeinia* have been made at Dehra Dun at intervals during the last 25 years. The results may be summarised to the effect that the seed germinates well particularly if soaked 25 hours in cold water before sowing (germination 76 per cent. and complete in four days). The small seedlings are rather more affected by weed competition than most species and are liable to be lost completely if not properly weeded. *Taungya* plantations with *mandua* (*Eleusine*) did well. It transplants only moderately well as entire plants with exposed roots, especially if natural forest seedlings are used presumably with poorer and less intact root system. It can be planted out in the rains as stumps with fairly satisfactory results with 80—90 per cent. survival at the end of the first season and 70 per cent in the second ; winter stump planting fails. As expected, much better results in survival and rate of growth were found with irrigation. Here also trouble is experienced from rats, porcupine, white-ants and frost, and the foliage is browsed a good deal. Bushy growth seems normal, but grown with other trees or fairly dense, a satisfactory stem is usually differentiated in time. Height growth is relatively slow here particularly in the open, averaging about $1\frac{1}{2}$ feet a year, with the best plants doing two feet or a little more, but in closed mixed crops, an average of three feet a year for eight years has been reached.

DISTINCTIVE FEATURES OF BAMBUSA TULDA ROXBURGH AND BAMBUSA NUTANS WALLICH.

By V. S. Rao, I.F.S.

The distinction between these two species of *Bambusa* is known to be of considerable difficulty and doubt in the absence of flowering specimens. No clues had apparently been discovered by the time two articles on the subject appeared in the *Indian Forester* for October 1929, one by the late Rev. E. Blatter on "The Indian Bamboos brought up to date" and the other by Mr. R. N. Parker in the shape of "Additional Notes" to the former. I am not aware of further discussions of the subject since.

Bambusa tulda and *B. nutans* are known in Northern Bengal by the names of "*jaotha*" and "*makla*" respectively, and it is a matter of common experience that the Garos or Rabhas, Rajbangsis, and hillmen can readily distinguish these two species by their field characteristics. I have also known some forest subordinates distinguishing them with ease. Last February Messrs. Shebbeare and Parkinson tackled the headman of a Garo Forest village on the subject but got very little out of him. They can tell one from the other because "they have been working with them all their life, and they know"; just as a Forester can readily tell sal from *pakasaj* (*Terminalia tomentosa*) though to a layman unacquainted with them they might appear "just the same".

I have since gathered a few tips from a Pahari Forest Guard and a Ranger and I am setting them down for the benefit of persons interested in the subject. I find them very useful and they have not failed me yet.

Bambusa tulda Rox. (Local name *Jaotha*).	*Bambusa nutans* WALL. (Local name *Makla*).
1. Internodes shorter than those of *makla*.	1. Internodes longer.
2. Has numerous longitudinal (vertical) white streaks on the internodes, especially on the lower ones.	2. White streaks absent.
3. The foliage is lighter.	3. Foliage heavier.
4. Rootlets on nodes occur up to a greater height above ground level than in the case of *makla*.	4. Rootlets do not occur so high.
5. The internodes can be clearly seen to zigzag.	5. The culms are straight; zigzagging not apparent.
6. Walls thinner.	6. Walls thicker.
7. Has a dwarf internode near about the base of the culm and this is definitely kinked.	7. Dwarf internode absent, no kink anywhere.

All these characteristics may not occur in every culm of a clump, but they can be seen in at least some of them.

For the first six tips I am indebted to Ambar Bahadur, Forest Guard, Rehti, and the last I learnt from Babu Dinesh Chandra Chowdhuri, Forest Ranger. Nos. 1 and 6 have also been corroborated by Mela, headman, Garo Forest village Khuntimari.

Note by the Forest Botanist.

Mr. Rao's note records useful field characters for distinguishing two kinds of bamboos locally called *jaotha* and *makla*, but the question arises whether these are really *Bambusa tulda* Roxb. and *Bambusa nutans* Wall. We have, in the Dehra Dun herbarium, flowering specimens of *jaotha* from the Apalchand Range, Jalpaiguri, Bengal, which correctly identify this bamboo with *Bambusa tulda* Roxb. The only specimens of *makla* that are available are those collected by Mr. Shebbeare and the writer last February near Khuntimari, but as no flowering material was available the identity of this bamboo remains doubtful. To the writer *makla* looks different to *Bambusa nutans* as we know it in Dehra Dun and it is possible that it may not be that species.

Gamble, who knew the Bengal bamboos so well, unfortunately does not give these vernacular names although he gives on page 31 of the Indian Bambusæ the Bengali names *jowa* and *matela*, both under *Bambusa tulda*, and they may correspond with the names *jaotha* and *makla*.

It now remains to collect good flowering and fruiting material of *makla*, when this becomes available, in order to settle its identity, and if it really turns out to be *Bambusa nutans* Wall., the characters pointed out by Mr. Rao will make it easier for forest officers to distinguish in the field two species which are "extremely difficult of separation when flowers are not available".—C. E. P.

MODERNISING THE INDIAN BULLOCK CART FOR FOREST WORK.

BY H. TROTTER.

The damage done to forest roads by iron-tyred bullock carts is too well-known to forest officers to need further comment. It may, therefore, be of interest to forest officers and also to forest contractors to know that the Dunlop Rubber Co. (India) Ltd. have produced special pneumatic rubber tyres and roller bearing hubs for bullock carts.

" This equipment has been tested under the various conditions that are usually encountered in India and it has been found that as much as 100 per cent. greater loads can be carried with less tractive effort, and at the end of this article are tables showing the comparative draught.

One of the great advantages of this equipment is that due to slow speed and to the special design of the outer cover, risk of puncture is negligible. The roller bearing hubs are packed with grease and do not require attention for many months.

The following are absolute facts :—

1. The same yoke can draw much greater loads, or the same quantity can be moved with fewer animals.

2. Vehicles of lighter construction and larger capacity can be used.

3. Loads are carried smoothly and silently—a definite advantage in the case of livestock, fruit and fragile goods.

4. Crops and roads are not damaged and no ruts are made by the passage of wheels.

5. Loads at least 50 per cent. greater can be carried at a faster pace with the same tractive effort.

6. On good roads draught is considerably eased, resulting in less fatigue to the bullocks; heavier loads; more loads per day for one cart, and more rapid transport.

7. A lower loading line can be obtained, reducing the time and effort required to load and unload.

8. Complete freedom from jolting and shocks.

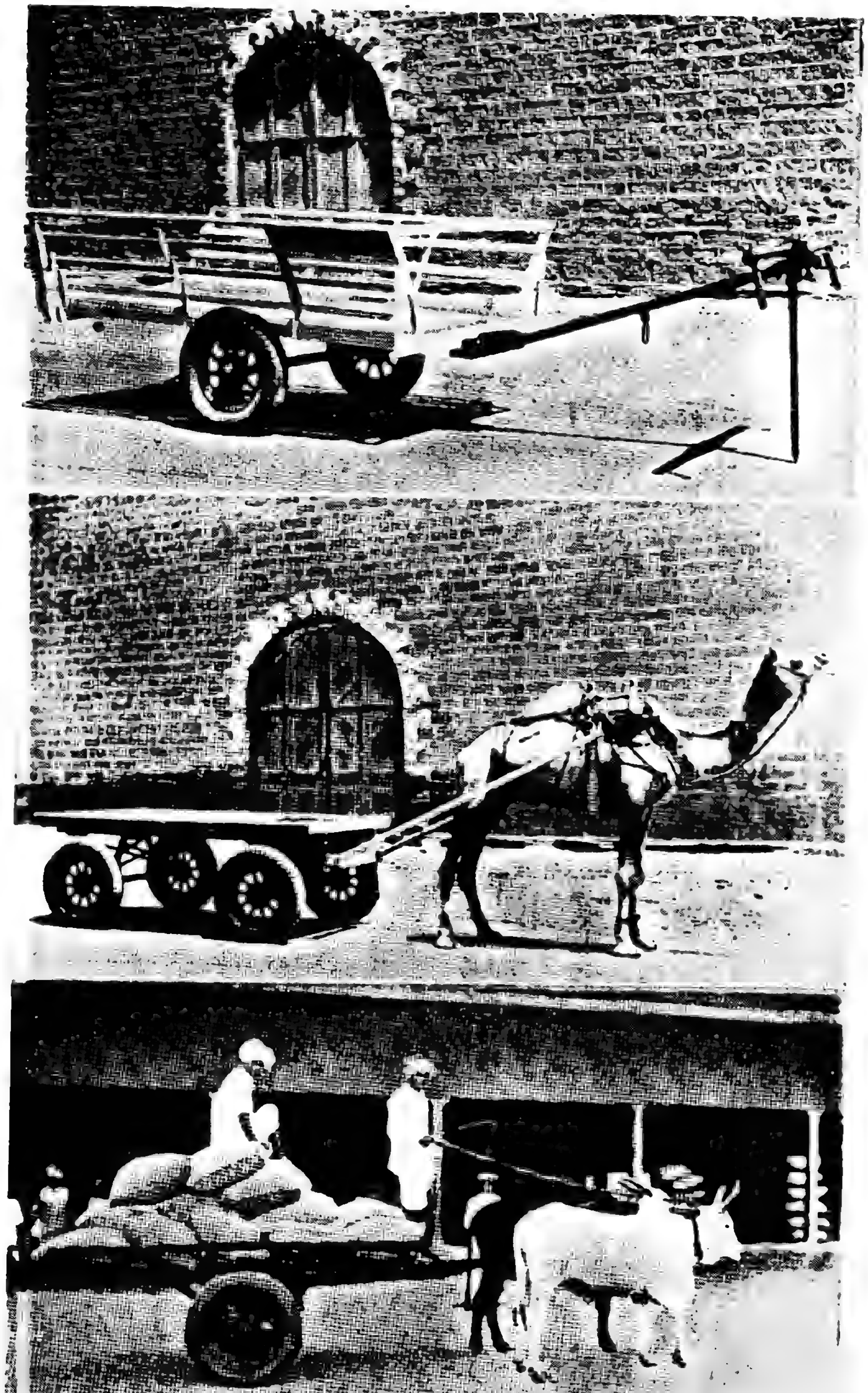
9. Road surfaces are not damaged as is the case when iron-tyred wheels are used.

It seems obvious, therefore, that the equipment of these tyres on country carts and for logging should be encouraged by Government and local bodies, in view of the fact that one of the problems which at present confront local and provincial authorities is the construction of roads suitable to accommodate the slow-moving bullock cart and the fast-moving motor vehicle, both of which, as at present equipped, have different destructive effects. The narrow metal rim used by bullock carts, added to the effect of the enormous play in the axle, tends to pulverise the macadamised road which the motor car (owing to its speed and width of tyre) proceeds to suck up, leading to the displacement of the metalling.

The Dunlop equipment has already been tested by the Imperial Institute of Agricultural Research, Pusa, and their report is being published in the September issue of the *Agriculture and Livestock in India.*

The new equipment has made bullock cart transport more silent and speedy; cost of road upkeep is greatly reduced, and the necessity for special bullock cart tracks on roads is obviated. The strain upon animals is alleviated owing to perfect balance and frictionless movement. In these and several other ways it is made apparent that modern conditions necessitate the development and use of equipment of this nature.

The tractive effort necessary to move a cart equipped with roller bearing wheels is approximately half of that required to move a country plain-axled wooden cart, so that without any additional strain on the part of the animal or animals, it is possible to draw from 50 per cent. to 100 per cent. greater loads. By virtue of the saving effected, income is increased accordingly, and it is possible to recover the additional outlay on the cost of the equipment within a very short period of time. There is also the important factor



Modernising Indian bullock carts for forest work.

T-11133. *Photos. Dunlop Rubber Coy., Ltd.*

that the life of the Dunlop All-Steel cart is probably double that of the ordinary cart, so that the increased profits are perpetuated over a long period."

The above information has been supplied by Messrs. The Dunlop Rubber Coy. (India) Ltd., P. O. Box No. 535, Bombay, and anyone interested in this subject would be well advised to get in touch with them. The three illustrations shown are sufficient to demonstrate the simplicity of the equipment. These photographs have been supplied by the courtesy of the above firm.

It is fully realised that the first question everyone will ask is "What about the price?". The prices quoted in Messrs. Dunlop's May 1934 price list for a complete set of two covers, two tubes, two wheels, two hubs (with bearings), and one axle, range from Rs. 102/- for an equipment for a maximum load per axle of 1,340 lbs. to Rs. 202/- for the same equipment for a maximum load per axle of 7,840 lbs. Brake equipment can be supplied, if required, for foot or hand action at an additional cost of Rs. 15/-. It would, however, be advisable for anyone interested in the subject to get into touch with Messrs. Dunlops as they have a large range of different types of equipment for various uses and axle loads, and the above prices must, therefore, be looked upon as examples only. Suffice it to say that a most serviceable looking cart with an all-steel body is quoted at Rs. 112/- complete (without uprights) f. o. r. Bombay. Removable uprights cost an extra Rs. 8/- only.

To those officers who sometimes have to travel at night by bullock cart (as the writer had to do on many occasions in his younger days in Burma) a pneumatic-tyred cart would be a boon indeed, and the transport of kit (including the best china and glass) by a rubber-tyred cart would undoubtedly result in a smaller bill for breakages at the end of the touring season. Apart from these minor amenities, however, the use of pneumatic-tyred carts would make a wonderful difference to forest road bills throughout the country.

OFFICIAL TESTS CARRIED OUT BY THE MINISTRY OF AGRICULTURE AND FISHERIES, AGRICULTURAL MACHINERY TESTING COMMITTEE.

REPORT NO. 46,

TABLE 1.

Comparison between the draught of a cart fitted with the Dunlop wheels and its draught when fitted with ordinary wheels.

Type of ground.	Load carried in cart.		Mean draught lbs.		Reduction of draught due to Dunlop wheels per cent.
	Mds.	Lbs.	Ordinary wheels.	Dunlop wheels.	
Wet grassland	18	46	263	187	29
" "	32	54	533	355	33
Wet stale plough land	18	46	639	544	13
Rough land ploughed with disc plough.	18	46	692	559	19
" " " " ..	32	54	1,110	888	20
Dry grassland	21	54	274	185	32
Cart track with heavy ruts ..	21	54	330	196	41
Rotary tilled seed bed	21	54	362	276	24

TABLE 2.

Comparison of pay load without the increase of draught when the ordinary wheels were replaced by the Dunlop wheels.

Type of ground.	Pay load carried in cart.		Mean draught lbs.		Increase in pay load due to Dunlop wheels per cent.
	Mds.	Lbs.	Ordinary wheels.	Dunlop wheels.	
Dry grassland	21	54	274	185	64
	31	18		231	
	37	42		270	
	40	22		286	
	45	14		319	
Rotary tilled seed bed	21	54	362	276	40
	31	18		345	
	37	42		384	
Cart track with heavy ruts ..	21	54	330	196	108
	31	18		223	
	37	42		254	
	40	22		289	
	45	14		330	
Wet grassland	18	46	263	187	41
	32	54		355	
Rough land ploughed with disc plough.	18	46	692	559	35
	32	54		888	

Conversion from lbs. into maunds @ 80 lbs. = 1 md.

Since the above article was written an interesting letter has been received from Messrs. The Dunlop Rubber Coy. (India) Ltd., describing the success achieved with a pneumatic-tyred timber cart in Ceylon. The letter is reproduced below :—

YAKAKA CAMP, CEYLON,
August 2nd, 1934.

MY DEAR A.

"I must drop you a line to let you know that the timber cart behaved magnificently. The men felled the biggest satinwood tree they could find yesterday, and when we arrived on the scene this morning with the cart we found the giant laid out on the ground, with a bole of 21 feet and a mid girth of $8\frac{1}{2}$ feet. It weighed about $1\frac{1}{2}$ tons. Unfortunately we had to saw off five feet at the base owing to defects, but the remainder was good enough for demonstration purposes. It looked impossible for this light contraption to lug it out of the forest and get it to the depot.

You would admire the skill with which these men hoist a log. To my consternation, however, I found that the tyres were only half inflated, and I had elected to walk down instead of taking the car, so I had no pump. Anyhow I told the men to go on and the only thing left to do was to get a pump, and we were over three miles from the camp, and it was eleven o'clock and not exactly freezing. I had to do it and fearing the tyres would burst, ran rather than walked, for we had loaded and got it on to the road, with the wheels almost on their rims. I was in dire anxiety whether my little Ford pump would do it as it was very poor one.

It did, and we got going at 12-30, and the bulls trotted that log into the depot without the slightest effort. The carter's faces turned from scepticism to rapture and there were great rejoicings, as the problem of getting large logs out without elephants was solved. It was a wonderful finish to a bad start, and I have got a lot of work for that cart, as we want 100 such logs out before the end of September.

I wish I had a camera, or rather a small movie, to have shown that log being hoisted and in transit. With the ordinary sling cart

four bulls would have been necessary and we had them in readiness, but the two in use would have none of it and cantered home smiling with this bit of a log.

You can imagine the impression it made up here, where one soon forgets the outside world."

Yours sincerely,
J. W. S.

REVIEWS.

RESIN TAPPING INSTRUCTIONS AND RULES.

PUNJAB FOREST LEAFLET No. 13.

The object of this leaflet is to standardise all resin operations throughout the Punjab and the North-West Frontier Province, the instructions and rules being binding on the territorial staff as well as on officers engaged in the compilation of working plans in which resin-tapping schemes are embodied. In short, the leaflet is a definite Standing Order, being the outcome of a full discussion at a Punjab Forest Conference at which all resin-producing divisions were represented.

The particular pine here dealt with is the long leaved pine (*Pinus longifolia*), known locally as *chir* and *chil*. Though the blue pine (*Pinus excelsa*) also grows in the Punjab, it is not economically tappable on account of remoteness coupled with a relatively short working season.

For the benefit of the staff a short account of the structure of the wood of *P. longifolia* is given. At first sight this brief dissertation on histology may appear superfluous but experience has shown that such knowledge is not possessed by all who are called upon to conduct resin-tapping operation. In a useful *résumé* at the end of this particular chapter it is stated, amongst other fundamental deductions, that the yield of resin can be improved if crops are maintained in a somewhat open condition. This is perfectly true ; there is, however, no indication in the leaflet to show that an attempt has been made to carry out research on this important subject of spacing of stems in relation to resin yield. It is suggested that in view of this industry having been in existence for over 20 years the time has arrived for work to be undertaken in this direction, so that where resin production is an important consideration the optimum spacing for different conditions may be ascertained consistent with the other objects of management.

Chapter 3 deals with enumeration. The instructions here might be improved by causing range or other officers to submit stock maps of areas to be brought under tapping for the first time and to enter on such maps unworkable tracts. An area may be unworkable on account of its precipitous nature ; it may be unsuitable in view of labour difficulties ; or uneconomical owing to too low a resin yield in consequence of excessive altitude, unfavourable northerly aspect or a fire in the previous season. These maps should serve as guides to the officials in direct charge of enumerations and should help them in avoiding unworkable tracts ; for if such areas are included in enumerations the number of tappable trees on paper will be an exaggeration which will, firstly, mislead the Divisional Officer when framing his budget and, secondly, result in a waste of money through an excessive number of plots, tools, etc., being made.

The light continuous (*gemmage à vie*) and heavy (*gemmage à mort*) methods are employed. For ascertaining the number of blazes in the case of tapping to death the well-known formula X+1, where X is the girth of the tree in feet at breast height, is utilized. It is stated that

the minimum girth of a tree which it pays to tap to death is two feet. In this connexion it must be remembered that an appreciable proportion of such small trees in a crop under tapping is likely to lead to a fall in the quality of light oils obtained in the factory.

The instruction that serial numbering of stems during enumeration should be done on the north side is sound since the figures punched in on this face are likely to remain intact longer: these figures should always be on the *firm* bark for on this they last a considerable time. The wording of paragraph 6 of Chapter 3 might be improved accordingly.

In the standard scale of tools and stores it is laid down that clay pots should have a small hole near the top. It is recommended that this order should be revised and each pot should have two holes placed *vis-ā-vis*. The additional hole will increase doubly the utility of the pot and so reduce the number of pots required. How many pots have to be discarded just because there is no second hole when the first one breaks away through rough handling!

The instructions in Chapter 5 on cutting new channels are defective inasmuch as nothing is mentioned about the direction to be followed in channel-making. Are channels to go round clockwise or anti-clockwise? Where, generally speaking, should the first channel be made? On the north, south, east or west? Surely some guidance is here necessary for the sake of uniformity and control. It is suggested that, wherever possible, the first channel should be cut on the south face of the tree and, thereafter, channel-cutting should proceed in a clockwise direction. The instructions in paragraph 1 of this chapter call for early revision.

The subject of depth of channels is an interesting one. A depth like ½ inch is all right for smaller sized trees, like those in the Landes where the felling rotation is relatively short; but are we quite certain that we are not justified in shaving deeper in the case of larger trees? Can we not safely go deeper in the case of trees with twisted fibre or in those of little value for timber purposes or in trees which are eventually utilized for firewood? So far it appears that we have

adopted a figure from the Landes, have adhered to it in a mechanical manner for many years and have failed to work out independently, through research, the depth most suitable in the case of pine forests in India. There is no gainsaying the view that research has lagged behind unpardonably in a matter of considerable consequence in a very important forest industry.

The mention of the Landes in paragraph 8 of Chapter 6 in connexion with the height of channels should remind us that the Landes is an entirely different proposition,—easy flat country. Tappers working on Himalayan slopes would justifiably scorn the Landes! The height to which Himalayan tappers freshen channels in the fifth year with the help of ladders, often perilously poised on steep gradients, is work which tappers in the Landes would, to say the least, find distinctly uncomfortable. In a set of instructions for resin-tapping in the Himalayas it is advisable not to mention the Landes at all. The quality of the work in the Himalayas is in no way inferior to that in the Landes and it is carried out in an infinitely more difficult country; the two tracts are not comparable; and a study of them both cannot but result in increasing tenfold one's regard for the work of the Himalayan tapper.

At the end of Chapter 9 the duties of Divisional Forest Officers and Gazetted Assistants are laid down. It would have been useful here to emphasize the great importance of energetically touring through resin-tapping areas as often as possible during the months of July and August as inspections at this particular time on account of rain are often neglected ; experience has shown that intensive inspection during this period has a marked effect on the quality of work done and the yield of resin obtained, since after May and June the months of July and August are the most important from resin outturn point of view.

Punjab Forest Officers are to be congratulated on compiling a most useful and very necessary set of instructions which are bound to result in uniformity in work, better control and better revenue.

J. E. C. TURNER.

KILN DRYING OF BRITISH COLUMBIA LUMBER.

BY J. H. JENKINS, B.A. S .., FOREST SERVICE BULLETIN 86, OTTAWA, CANADA, 1934.

It is now universally realized that proper seasoning and handling of wood after conversion is an important step in the efficient utilization of forest resources of a country, and everywhere increasing attention is being devoted to improve the practice and methods of seasoning. The lumber industry of British Columbia is a very big one, and its magnitude can be realized by the estimated figure of $1,000,000, given in the bulletin for the annual kiln drying loss in the Southern Coastal region of British Columbia, based on the studies made by the Vancouver Forest Products Laboratory in 1925. During the last 10 years, the laboratory at Vancouver has been engaged in studying the difficulties experienced in the kiln drying of British Columbia woods, and as a result of its work, and also on account of the vast improvement in the kiln design brought about by the kiln engineering firms on the Pacific Coast of America, the kiln drying of British Columbia lumber is at present on a very satisfactory basis.

The bulletin under review deals with the general principles of kiln drying, with particular reference to the kiln drying of British Columbia woods. Fortunately for the British Columbia lumberman, they have only a few species to deal with, and none of them is refractory at all, but even then they have their problems. Western red cedar is liable to wet pocket formation and collapse. The author has tried to explain the fundamentals of kiln drying in a very clear manner, and the bulletin is sure to be found of use by those engaged in the practice of kiln drying not only in British Columbia, but also in other parts of the world. S. N. K.

THE FAMILIES OF FLOWERING PLANTS, VOL. II, MONO-COTYLEDONS.

BY J. HUTCHINSON, F. L. S., ASSISTANT IN THE HERBARIUM, ROYAL BOTANIC GARDENS, KEW. (MACMILLAN. *Price* 20*s*.)

The first volume of this work dealing with the Dicotyledons appeared in 1926 and those who have been using that book have no

doubt felt the want of a similar one dealing with the Monocotyledons. Its appearance will therefore be welcome.

It is felt, by both professional and amateur botanists, that the Monocotyledons are a more difficult group of plants to deal with than the Dicotyledons. They are much more a group for specialists, the grasses, orchids, and other groups admittedly requiring life-long study; the collaboration of Mr. Hutchinson's colleagues at Kew who have specialised in these groups, Mr. C. E. Hubbard, in the Gramineæ, and Mr. V. S. Summerhayes, in the Orchidaceæ, and of Mr. J. E. Dandy of the Botanical Department, Natural History Museum, in the Hydrocharitaceæ, adds therefore to the value of the work.

As was the case in the first volume dealing with the Dicotyledons some rearrangement has been made in the families of the Monocotyledons, for the author has, in arriving at this new arrangement, "put aside certain prejudices and ideas which have largely up to the present been accepted as botanical gospel." The character of inferior and superior ovary hitherto so largely used in distinguishing the Amaryllidaceæ and the Liliaceæ has been, it is thought, over-emphasised in the past and greater importance is now attached to the type of inflorescence which in the Liliaceæ is never in umbels, and in the Amaryllidaceæ is umbellate with an involucre of bracts. This has resulted in the reduction of the size of the Liliaceæ, an already large and unwieldy family, by the removal of some groups. The tribes Agapantheæ and the Allieæ have been transferred to the Amaryllidaceæ; the Medeoleæ and Parideæ to which latter belong Trillium and Paris, so well-known to foresters in the north-west Himalaya, now constitute a separate family the Trilliaceæ; Smilax and some allied genera are placed in the Smilacaceæ; Agave, Yucca, Dracæna and others in the Agavaceæ and the genus Xanthorrhœa, Australian grass trees, is, with others, in the Xanthorrhœaceæ.

Some of these proposed changes are, as pointed out by the author, rather drastic steps which may not appeal to all botanists but the author's conceptions on the subject are of undoubted value and the reduction in size of large and unwieldy groups has its advantages.

The book is characterised by the same originality and freshness that the first volume carried with it. Many interesting points dealing

with the new Phylogenetic system proposed and with parallel development in the Dicotyledons and Monocotyledons are discussed. Eight pages are devoted to a useful artificial key to the 68 families dealt with and there are numerous illustrations from the author's pen, both original and adapted, among which are 29 illustrating the tribes of the Gramineæ after drawings made chiefly by Mr. C. E. Hubbard. As the number of families dealt with in this volume is fewer, 68 against 264 in the first volume, the author has included useful keys to the genera of the families except for the Orchidaceæ, for which Schlechter's classification of the tribes is given, and the Gramineæ for which Mr. Hubbard gives a key to the tribes and sub-tribes.

Mr. Hutchinson is to be congratulated on the production of this useful book which, with the first volume dealing with the Dicotyledons, should find a place in the library of every progressive forest officer.

C. E. P.

EXTRACTS.

IS THERE A NATURAL CROP ROTATION IN FORESTS?

The establishment in forests of reproduction other than of the present dominants is usually interpreted as evidence of succession. Usually the site becomes occupied by progressively more mesophytic species, or those more tolerant of shade and competition, and able to become established on deeper accumulations of litter. In forests under management the natural course of succession is rarely allowed to proceed far, but is repeatedly thrown back to the earlier sere due to lumbering.

Foresters have long observed these common phenomena, and indeed all methods of natural reproduction are predicated on either maintaining the existing sere (as in tolerant selection forests) or throwing back succession to a point where the desired crop species will find optimal seedbed conditions. It is also common observation that not only is this irreversible successional tendency present in forest reproduction, but that habitat conditions under individual trees often appear inimical to the reproduction of the same species. In some cases the reproduction which occurs exhibits a tendency contrary to natural succession. Apart from studies of toxic substances excreted by roots, such as *juglone* in the case of black walnut, there have been few careful investigations ; but a considerable body of general observations have convinced many foresters that there is a natural " crop rotation " in forests, superimposed on the succession of the community as a whole.

In a recent paper under the title " the requirement of forest soil for crop rotation " Wallmo presents additional evidence in support of the hypothesis that a tree will not reproduce in its own litter as well as under another species. In earlier papers, examples were cited from observations made in the spruce fir forests of the Vosges and Jura since 1890 ; as well as in Switzerland. Wallmo now gives numerous examples from Austria and Sweden. In irregularly-cut peasant forests in Austria, scotch pine, (*Pinus silvestris* L.) was observed reproducing under pure spruce stands to the virtual exclusion of Norway spruce, (*Picea excelsa* Link) and on sites where the shade was believed too dense for pine. Pine seedlings appeared more vigorous than spruce. Similar illustrations are given from Sweden. The establishment of spruce under pine is of course much more common in all parts of the world. But cases of even birch coming in under conifers as cited by Wallmo seem " unnatural " rather than the opposite. A careful study of the vegetation and physical factors in such cases would probably show that some external influence has initiated a new sere. Unfortunately Wallmo presents no such data.

Jensen has cited similar examples of succession on Danish heaths, and the failure of successive generations of *Sorbus* and other trees of the same family in the same nursery bed. Change of timber crops in the forest is frequently advisable due to infection of the soil with root rots such as *Fomes annosus*, or because of soil deterioration.

The writer in common with many American students of reproduction in spruce-fir forests of north-eastern North America has frequently observed that balsam fir

(*Abies balsamea* L.) appears very abundantly under red spruce (*Picea rubra* Link) stands, while spruce seedlings may be practically wanting. Spruce appears to be more persistent under a closed canopy however and especially in competition with hardwoods. From studies made in north-western Maine since 1924 the mortality of fir saplings has been far greater than that of spruce. Many such cases of apparent alternation of species may be explained by relative differences in the efficiency of seed production (production less losses) of the different species concerned. Surprisingly little is still definitely known of the specific differences in seedbed requirements of associated species. Until carefully controlled experiments have proven otherwise it would seem best to explain all cases of crop rotation by the natural laws of succession operating in each forest association. (Henry L. Baldwin, Penn State Forest School, State College, Pa).

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SOME FOREIGN WEEDS AND THEIR DISTRIBUTION IN INDIA AND BURMA.

By K. Biswas,

Royal Botanic Garden, Calcutta.

Mr. A. C. Joshi's note on the occurrence of *Croton sparsiflorus* in the United Provinces, published in *Current Science*, 2, 344, 1934 (6) prompts me to put down by my observations regarding the distribution of some of the common harmful exotic weeds established in this country.

The interesting study of migration of foreign plants dates from a very early period, as far back as 1786, the date of the foundation of the Royal Botanic Garden, Calcutta, (the then Hon. East India Company's Botanical Garden, Calcutta) and the Serampur Botanical Garden, generally known as Dr. Carey's garden. During this time Roxburgh, " the father of Indian Botany," and Dr. Carey of great fame, started cultivating in their gardens at S.bpur and Serampur various species of foreign and indigenous plants with a view to have a suitable botanical garden of scientific value near Calcutta. This work was followed by such eminent botanists as Voigt, Wallich, Griffith, Buchanan, Hamiltcn, Falconer, Thomson, Anderson, Clarke, King, Gamble and Prain. Thus by the time Bruhl published his *Recent Plant Immigrants* in 1908, (3) the Botanic Garden at Sibpur during the course of one hundred and twenty-two years formed a centre of distribution of a large percentage of plants at present found in the neighbourhood of Calcutta in the district of Hooghli, Howrah and the 24-Parganas. Coastal invasion of foreign plants either by sea or by ships calling at the various ports of this country may be considered another source of migration of foreign plants. Exchange relation in plants with different gardens and introduction of seeds by private individuals may be other important factors of local migration of plants. The problem of distribution and dispersal of plants is too large to be discussed here. I refer the reader to the book entitled *The Dispersal of Plants throughout the World* by H. N. Ridley, 1930, (10) for sufficient information on this subject. The authors of the local floras such as Prain, Cooke, Gamble, Brandis, Duthie, Haines and others

have mentioned in their works some of the plant intruders of this country. Kashyap has recorded some of the foreign plants in his article on "*Notes on some foreign plants which have recently established themselves about Lahore.*" ([7]) "In the list of species and genera of Indian Phanerogams not included in Sir J. D. Hooker's *Flora of British India*" ([5]), Calder, Narayanaswami and Ramaswami have compiled, in alphabetical order, the names of species published up to 1924 which were not noted in *Flora of British India*. This work covers 157 pages. Recent writers such as Bruhl, Blatter, Parker, Kanjilal (Senior and Junior), Sabnis, Fyson, Parkinson, Mayuranathan, Tadulingam and the writer and others have also reported in their works some of the foreign plants. There has become, as the author experiences during his association with the herbarium of the Royal Botanic Garden, Calcutta, a large accumulation of foreign specimens. A comprehensive list of these 'Plant Immigrants' will be published in course of time.

Some of the most common foreign weeds chiefly hailing from tropical America have of late been almost terrestrial pest in different parts of the country. These weeds cover sometimes acres of field or open places and miles and miles along the railway lines forming more or less a pure association of their own. *Eupatorium odoratum* encroaches upon outskirts of the tropical evergreen forests in South Burma and penetrates into the Terai of the Eastern Himalayas sometimes struggling to replace the characteristic Savannah formation of this region. Some again spread rapidly in the plains and ascend with equal vigour to the hills sometimes reaching even an elevation of 10,000 feet. These plants are mostly perennial and may be called in general weeds including herbs, undershrubs and climbers. Some of them flower throughout the year and some in spring from January to February. Fruits ripen before the rains from March to April. Some of the species more or less dry up in the hot weather. The climax of growth of most of these species reaches within two to three months after the rains—say, from September to December. The rapid spread of *Eichhornia speciosa*, *Croton sparsiflorus*, *Eupatorium odoratum* and *Lantana camara* within a fairly short period has become such a menace to cultivation that questions were raised in the local Legislative Councils to find out means for their control and eradication. The question of eradication of *Eichhornia speciosa* (water hyacinth) is still uppermost in our mind. The writer, as hinted in his paper entitled "*Role of Aquatic Vegetation in the biology of Indian waters*" ([2]) is of opinion that the eradication of water hyacinth, as also the other terrestrial species, can alone be done by mechanical means and organised labour. I have studied the question of eradication of water hyacinth since it was tackled by Dr. P. Bruhl from 1920 onwards. I have had the opportunity of visiting different affected areas in India and Burma. I am convinced that there is no royal road to eradicate this pest save and except by mechanical means. Utilisation of water hyacinth compost as manure is, I believe, not so very tempting to the agriculturists as to induce them to apply their whole-hearted effort for eradication. Manufacture of alcohol from water hyacinth on a commercial scale is rather doubtful, but if it proves successful by the attempt of Dr. H. K. Sen, it might be a tempting offer. In any case in this country under the present circumstances it appears to me that a certain amount of forced labour or legislation might have, in the beginning, desirable

effect to stir up the landholders to take up the work in right earnest. The prospect of utilizing water hyacinth as manure, potassium salt, alcohol and other bye-products might also encourage educated people and zemindars of the affected areas to influence the tenants for exerting their manual labour to the full extent for the eradication of this pest which day by day is leading them to heavy financial losses.

The control of terrestrial pest is not so very complicated, as it requires keen watch in uprooting the plant before the fruiting period. In this way after three or four years' weeding they will be quite under control. In the forest areas careful burning of the weeds in proper time will have considerable effect in checking their growth. Thus by careful weeding the author finds large plantations, gardens and estates are kept free from growth of undesirable weeds. In this country edaphic and climatic conditions, vast areas, finance and other labour factors are not favourable to the use of spray and chemicals.

The American plants seem to have particular liking for the Indian soil, so that once they can set foot on any part of India they spread like wild fire in no time. Of such may be mentioned the Euphorbiaceous South American *Croton sparsiflorus* which Prain records as occurring in the Royal Botanic Garden in 1904. This alien species was evidently, as Mohr refers in his *Plant Life of Alabama* in 1901, was introduced in ballast and found its way to India *via* Malay Peninsula, South Burma and Aracan sea coast. Both Bruhl and Joshi remark that this plant favours riverside and water courses. The writer thinks that this plant first settles down along the riverside, water courses of various sorts and even along the edges of ditches. This is evidently due to its innumerable seeds having been washed down by rain water which are finally distributed by the current of rivers. The seeds thus carried by water are stranded along the margins of water courses or open *chars* of rivers and canals and grow there under suitable conditions. In this way the plants are securely placed in their new habitat, and after first fruiting period the cocci are scattered and the area of the spread of this plant increases in mathematical proportion. Its access to Benares is very likely by boats plying in the river Ganges or by human agency or by trains running from Bengal to the Upper Gangetic plain. The writer during his recent tour followed this species down to South Burma where it might have reached by the sea along the Aracan sea coast. Its luxuriant growth in masses forming pure association in open fields in some parts of Bengal sometimes lends a touch to the landscape. It spreads right up to the foot of the Himalayas in Northern Bengal. In South India it has been observed by Mr. V. Narayanaswami that this plant spreads particularly along the railway lines and embankments and extends up to the foot of the Nilgiri Hills. It is not very common in Bihar and Orissa. It has become a veritable pest in Bengal and it is high time that steps should be taken for its eradication, as its growth increases not only the labour charges but also reduces the fertility of the soil. The species appears to favour moist tropical areas and slightly alkaline soil conditions. The plant is not liked by cattle. *Scoparia dulcis*, another tropical American erect small medicinal herb, unknown in Roxburgh's time, is nowadays common everywhere and extends even up to the Terai region chiefly following the open roads and pathways. This plant belongs to the family of Scrophularineæ.

Eupatorium odoratum, a Compositaceous plant, known by the local people as "Assam lata," is a tall scandent undershrub introduced after Roxburgh's time from Jamaica, West Indies. Hooker reports its occurrence in Assam, S. Burma and Malay peninsula. This species is at present wild everywhere in the eastern and southern parts of Indian Empire. This is the most common plant along the railway lines, in village shrubberies and fallow lands in Assam, Bengal, Southern India and Burma. In Assam, especially along the borders of Sylhet hills and the bases of the Naga Hill ranges, it becomes such a dominant species that it may be called *Eupatorium odoratum* association. Such association is not infrequently met with in the secondary formation of the tropical rain forests of S. Burma. Predominance of its growth is also noticed along the base of the Sikkim, Bhutan, the Garo Hills, Khasia and Jaintia hill ranges and Manipur in the east and Madhupur jungle, Mymensingh, Bengal in the west. It is very likely that the plant might have been introduced from the West Indies to India and Burma by seeds confined to the ballast heaps of cargo boats calling at Singapore. From the Malayan port the plant found its way into Lower Burma. The line of distribution gradually extends further inland and then bifurcating—one branch extending up the Duars of N. Bengal-Assam ranges where it finds ideal condition of growth ; and the other to the west Bengal, *via* Chittagong Hill Tracts, Hill Tipperah, Dacca and Mymensingh. It is now making attempts to encroach upon the boundaries of Bihar and further north-west towards upper Gangetic plain. It rapidly replaces the indigenous shrubby and herbaceous association.

The herb *Ageratum conyzoides* Linn., sometimes known as "Goat Weed" belonging to the family of Compositæ, is a native of tropical America. It follows more or less the same path as that of *E. odoratum*. The plant is a small gregarious herb spreading nearly all over the country except very dry parts—ascends from the sea-level to 8,000 feet or more in altitude in the eastern Himalayas. The species is abundant in Ceylon too and this species is considered to have been introduced by man to the different parts of the world. *Mikania scandens*, another tropical American plant of the family of Compositæ, unknown in Voigt's time, has of late been a widespread climber. The eradication of this climber is difficult due to its vegetative propagation by roots developing from the nodes and to its profuse growth of flower heads. Its occurrence on shrubs, trees, bushes and marshy areas, even over choked-up tanks, is a familiar sight in the Lower Gangetic and Assam and Burma plains. Hooker reports its occurrence in Assam, Burma and Malay peninsula. The spread of this climber may carefully be watched by the neighbouring provinces and steps should be taken to prevent its entrance. The Central American *Lantana camara* of the family of Verbinaceæ commonly met with in this province in village shrubberies is a veritable terrestrial pest in the Deccan peninsula and the Carnatic. It is reported to occur in the Lower Hills forests of the E. and N.-W. Himalayas, Bengal, Assam, Burma and the Andamans as well. The plant is seriously interfering with cultivation and forest operation and its eradication has attracted attention of local people. Of recent years the South American species, *Heliotropium curasavicum*, recorded from the Madras Presidency, though grown in Serampore was not mentioned by Prain in his *Bengal Plants* (8) and in his paper on the "*Vegetation of the Districts of Hooghly, Howrah and 24-Parganas*" (9).

Bruhl mentions it as "domesticated in Serampore." The writer finds it spreading over moist areas of Salt-lakes near Calcutta. It is gradually approaching the town covering sometimes in dense masses large plots of lands. But *Suæda maritima*, as noted in my paper on the "*Flora of Salt Lakes, Calcutta*" ([1]) gains the upper hand in the struggle for existence between the two species in the salt lakes proper. The Tropical American Solanaceous plant *Solanum glaucum* is an interesting slender rather tall undershrub with beautiful glaucous linear acute leaves and pale bluish flowers. It has been found growing recently in the neighbourhood of Sundribuns. It has been noticed lately proceeding further inland in the 24-Parganas not very far from Calcutta. It was cultivated in the Royal Botanic Garden in 1899. *Argemone mexicana*, a native of Mexico, as noted by Joshi, is a common roadside and field weed growing everywhere. This Mexican poppy of the family of Papaveraceæ has already been mentioned in 1875 by Hooker and Thomson in the *Flora of British India* as "naturalised throughout India." The seeds of this species are disseminated by rain-wash. *Opuntia dillenii*, another American cactus, is confined to the sandy areas especially along the seacoasts of Orissa and drier parts of India, where the spread of this species is so much felt that attempts have been made by the Agricultural Department to kill the plants by means of (cochineal) insects. Dr. H. Pruthi of the Zoological Survey of India has been kind enough to inform me that two cochineal insects, *Dactylopius tomentosus* and *D. indicus* are useful for the eradication of prickly pear (*Opuntia* sp.). The Loktak lake of Manipur and other marshy areas in Assam are infested with *Polygonum orientale* which is now being replaced by *Eichhornia speciosa*. The representatives of Gramineæ are well-known for their long range of distribution and adaptability. I mention here *Anastrophus compressus* only, recorded from this country for the first time by Bruhl occurring in the Royal Botanic Garden ([4]). Although this plant has been spreading rapidly on the grounds of the Botanic Garden, especially in shady areas, and observed to occur in and about Ballygunge maidan, its spread is not noticed during these years to be so fast as that of its other kindreds.

(*Current Science, Vol. II, No.* 11, *May* 1934, *page* 422.)

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